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There is a Lot More to Road Building

Than Dropping a Pebble or Two Into a Chuck Hole

F. W. Allen, Deputy County Engineer of King county, Washington, has contributed an article on the 'Location and Estimation of Highways' that every engineer on the Pacific Coast should read. We expect to publish it in the September number. It will furnish food for thought that will be full of mental nourishment.

WHAT IS THE CAUSE OF COLLAPSED OIL WELL CASING? Do you know? Perhaps. Even if you do, or think you do, it will be worth your while to read Dorsey Hager's analysis of the underlying causes of this frequent source of trouble in the oilfields. If you have read this announcement so far, you can form your own conclusions as to the worth of the September number.

Then there is an article on the new 'Reinforced Concrete Trestle Over Yolo Basin' from data furnished by Mr. A. B. Fletcher, California State Highway Engineer; another on the 'Reinforced Concrete Supply Pipe for the Sooke Water Supply,' a British Columbia project in which a reinforced concrete siphon is being installed to operate under a static head of 65 feet; and a paper on 'The Manager of an Irrigation Project' by the Director of the U. S. Reclamation Service. And this isn't all by any means. You will have to send for this issue to get it all. And why not?

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EDITORIAL

FOR the first time in the history of expositions, China has applied for space for a machinery exhibit at the Panama-Pacific Exposition. The space asked for is 2000 square feet in the Palace of Machinery, thus making the new republic of China an exhibitor in every department of the Exposition. The total appropriation is $750,000.

THAT municipal ownership is not an infallible panacea for all civic ills is shown by the report of the operation of the Seattle municipal railways. The Public Utilities Department, through Mr. A. L. Valentine, superintendent, has estimated a deficit for 1915 of $36,-397.25. This estimate is based upon the result of operation during the last two months, and is not a very reassuring exhibit for the Seattle taxpayers.

ONE of the many factors determining the success or failure of a road is the degree of skill displayed in the preparation of the foundation. In the case of the concrete road at the San Francisco Presidio, described in this issue, effective use is made of the old water bound macadam which had been thoroughly compacted through years of use, although the surface has long since outlived its usefulness. The right-of-way for the road being along a well drained ridge, few drains were required. After truing the surface, the concrete was laid direct upon the old macadam, while 4-inch shoulders of new macadam were laid on either side.

CONSULTING architects for the San Francisco civic centre turned down asphaltum as a wearing surface for the street in favor of vitrified brick for the reason that the latter harmonized with the color scheme. We have the delicate shade of red as shown by the brick vying with the green of the lawn in front of the plaza and the gray of the granite walls of the new city hall. Thus for some $200,000 we have achieved a triumph of estheticism as far as the one section of pavement is concerned, but as the human eye has a tendency to rove, what will be the artistic effect of the single patch of red in contrast with the preponderance of grayish black in the adjoining asphalt? It would appear that in our efforts to achieve a complexion, we have only acquired a freckle.

WE have commented many times upon the increased use of graphic methods of conducting engineering studies of various kinds. Mr. A. T. Parsons contributed in the issue for April last an interesting article on the use of stick models for the study of oil-bearing measures in the California fields. In this issue Mr. L. G. Huntley shows how, by the graphic representation of underground and surface topography, a correct understanding of conditions is greatly simplified. If greater use were made of graphic models to supplement the usual lengthy technical reports, boards of directors would have a more intelligent understanding of the work of their engineers, and incidentally, through a better understanding, bring about a closer coöperation between the engineering and executive branches of the enterprise.

AN amusing example of 'hoist with his own petard' is afforded by the situation in which the City Council of Los Angeles recently found itself. In order to make as good showing as possible in its efforts to sustain the 40-cent rate established by the Council for natural gas, the Council employed Mr. Arthur B. Kelly as an expert gas engineer to assist the city attorney in defending the City in the injunction suits brought by the gas companies. Unfortunately for the city, Mr. Kelly could not present affidavits and expert testimony that would justify the City's rate, and so the matter presented by him will be used by the companies themselves as an aid in presenting their case before the court. The feelings with which the Council authorized the payment of Mr. Kelly's bill may be imagined.

ANOTHER instance of modern engineering skill in the utilization of by-products is shown in the Gatun hydro-electric development for the Panama canal. The Gatun spillway dam was necessitated in order to conserve the flow of water from the Chagres river for supplying the Gatun locks. The surplus water impounded by this means is used for the development of 7500 kilowatts of electric energy by means of Pelton-Francis turbines operating under an effective head of 75 feet and direct connected to General Electric generators. Thus is provided ample power for the operation of the enormous gates and other locking machinery, lighting, and for the electric 'mules' that are used for towing vessels through the locks. Provision for doubling the capacity of the plant has been made, in case the necessity should arise at some future date for operating the Panama railroad by electricity.

ONE way of avoiding high rents is to move to a cheaper house. This simple solution of one of the problems of domestic economy has been adopted by the City Commission of Sacramento with highly satisfactory results to all but the expectant landlord. The location of the Sacramento by-pass, for which bonds were voted some months ago, had been established upon the prop-

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erty of one George Swanston. As Mr. Swanston had ideas of his own as to the value of his property, recourse was had to condemnation proceedings, at which, to the consternation of the City Commission, Mr. Swanston's contentions in the main were upheld and a valuation was fixed for the property of $375,000. As this sum would make a hole of no small proportions in the amount provided for doing the entire work, the Commission has abandoned the former location and reëstablished the site for the by-pass at Bryte's Bend. Plans and specifications for the new levees were approved about a month ago, and, according to the usual procedure, owners of adjacent property have been called upon to construct the levees. Should they fail to commence work within three months of receiving notice, the State Reclamation Board will take action.

IN establishing rates to be charged by the Pacific Gas & Electric Company for delivery of electric energy to the city of Antioch, the California Railroad Commission has laid down several fundamental rules that will govern rate making in the state of California for a long time to come. These rules are in effect that the cost of generating and transmitting electricity is wholly separated from the cost of distribution in any city; that rates must be fixed with regard to the money that has been honestly and economically spent in constructing plants, no allowance being made for 'unearned increment' of property; little weight will be given to any corporation's claim for values as a 'going' concern; and that cost of distribution should be borne by each community.

In arriving at the rate to be charged for electric energy delivered at the city limits of the city of Antioch, the following values were fixed by the Commission:

Hydro-electric plants	$14,675,174.26
Steam-electric plants	5,455,282.16
Transmission system	5,930,529.10
Total	$26,060,985.52

Figures given for annual operation for the year 1914 are:

Interest at 8 per cent, depreciation, and maintenance	$2,408,377.66
Operating cost	1,171,978.90
Power purchased	824,200.00
Total	$4,404,566.56

The above figures formed the basis of a rate for delivery on a wholesale basis of $0.007312 per kilowatt-hour. This would appear to be a reasonable rate from any standpoint, provided, of course, that the load factor is favorable. We believe that lower rates have been quoted to private consumers where the load has been practically continuous. The Canyon Power Company of Oakland was the only bidder for power developed by the Lahontan dam and power-site of the United States Reclamation Service, the bid being $0.0025 per kilowatt-hour during the summer and $0.00375 during the winter, which gives a minimum annual income of $14,000, a maximum of $30,000, and an average of about $20,000 per year. Some of the smaller power companies in California which develop power for their own use, dispose of their surplus at prices even lower than the above. Whether or not a rate established in this way is profitable to the company depends solely upon the load factor. The hydro-electric companies employ a skilled staff of technical salesmen for the sole purpose of increasing their day load, and with a degree of success that is shown in the steady improvement of the load factor year by year. The same investigation is to be made for all other power companies in the state which are selling electric energy to more than one city.

DURING the second week of July a notable gathering took place in the city of Edinburgh. The occasion was the celebration of the tercentenary of logarithms, devised by John Napier, eighth Laird of Merchiston. His now famous work, 'Mirifici Logarithmorum Canonis Descripto,' was printed in Latin and dedicated to Prince Charles Stuart, who lost his life on the scaffold. The word 'logarithm' had not been invented, the word 'artificials' being the expression used in antithesis to numbers that were 'natural.' The publication of the book was received with enthusiasm by scientists and was translated into English by an Englishman named Edward Wright. Another Englishman, Henry Briggs, used it to expound to his students in Gresham college, and made valuable suggestsions for its improvement that were subsequently acted upon. Napier was the first British writer to make a contribution of lasting value to the science of mathematics, and was a contemporary of the Frenchman Descartes who is regarded as the father of modern algebra. Napier was an alumnus of the old University of St. Andrews, of which Andrew Carnegie is now Lord Rector. He was a strict Presbyterian and dabbled in theology, having written a dissertation on the cryptic book of the Revelation. He also was something of an agriculturist, carried on some experiments of note on fertilizers, and invented a number of mechanical appliances used in coal mines. Napier did not long survive the publication of his discovery. He died in 1617 and was buried under the shadow of Edinburgh castle in St. Cuthbert's churchyard. It is fitting that the University of Edinburgh and the Royal Society should commemorate his name and that the whole world of science should pay tribute to the memory of the man whose contribution to the sum of human knowledge has been of incalculable benefit.

AS has been anticipated, the Interstate Commerce Commission, in a decision handed down August 1, has granted an increase of 5 per cent in freight rates to railroads operating in the territory north of the Ohio and Potomac rivers and from a vertical line drawn through Buffalo and Pittsburgh west as far as the Mississippi river.

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REVIEW OF THE MONTH

RUMORS of war, with the Balkans as the storm centre, have been succeeded by grim reality. The long smouldering fires have sprung into flames, kindled apparently by the assassination of the heir to the Austrian throne by a Servian. Austria opened hostilities, thereby involving Russia on the one hand and Germany on the other. France has taken a hand in the fray and will try to wipe out the memory of 1870, while England has been drawn in against her will in order to protect her own interests. The long dreaded general European war has come with appalling suddenness, and the one hope is that it may end just as quickly as it has begun. War nowadays is a very different thing from that of the days of our own Civil War. New battleships are a matter of years in building, while the terrible destructiveness of modern armament is such that comparatively few pitched battles will decide the issue. The monetary cost is another item that in itself is so great that a protracted struggle is out of the question for financial reasons.

FORTUNATELY, the United States is remote from the zone of conflict and has no interest in the jealousies, intrigues, and racial hatreds of Europe. On the other hand, a war of such colossal proportions can not fail to have its effect upon America and American institutions in many ways. Our financial relations with Europe have been increasing to a marked degree, and many American enterprises are financed abroad, especially those in the California oilfields. A profitable market for American products, especially foodstuffs, will be temporarily withdrawn, and the bumper crop of this season will have to find a market as best it can. Steps have been taken to avert any financial disturbances; the various stock exchanges have been closed until further notice, and Wall Street is standing 'pat' until the situation becomes clarified. The new banking laws provide for emergency currency which may be issued at any time at the discretion of the Secretary of the Treasury, so in many ways it is not impossible that the United States may be the financial gainer at the expense of war-torn Europe.

INDUSTRIAL paralysis, temporary, of course, but paralysis nevertheless, will result from calling out the reserve military forces of Europe. American trade, therefore, in nearly every line should receive a decided impetus, if means can be found for transporting the various commodities in demand. Cash payments are the rule in war times, and much gold should flow toward this country in consequence. The lack of an American merchant marine will make itself evident in no uncertain terms, and when it is brought home to our legislative bodies *via* the pockets of their constituents, perhaps it will help to promote a revision of our antiquated shipping laws so that in the future we may not be in a similar predicament. It would be idle to attempt to prophesy what the outcome will be. One thing, however, is evident. Our boasted civilization is but a thin veneer, at best only skin deep. The dove of peace installed such a short time ago at The Hague has proved to have been merely an effigy, while the Carnegie temple built with American dollars has been succeeded by the 'big stick' rampant. There will be but little competition for the Nobel prize this year.

IN the meantime, our own relations at home and abroad stand out in pleasing contrast. Victoriano Huerta, erstwhile dictator and everything else of Mexico, has succumbed to the pressure brought to bear upon him by American diplomacy, and to which must be added the gradually lessening distance between himself and the cohorts of General Villa. Francisco Carbajal as provisional president is the present incumbent at Chapultepec castle, and during the interregnum is conducting negotiations with the Constitutionalists under General Carranza looking toward the ultimate occupation of Mexico City by the latter with amnesty to the Federalists, and, we hope, the prompt holding of a general election in which the voters will have a reasonable opportunity to exercise their franchise without too much intimidation. The course to be pursued by the Zapatistas is still open to conjecture, but with a united Mexico confronting them, it is believed that they will feel inclined to discretion as the better part of valor and take their share of the patronage that will be the reward of the faithful.

IT would appear that the chances for a resumption of order in revolution-scarred Mexico are brighter than they have been since Madero succeeded in overthrowing Don Porfirio. From every standpoint it would seem as if the present was the psychological time to return to the ways of peace. Europe, with a general war on its hands, will be so occupied with its own affairs that a pressing of claims against Mexico will, temporarily at least, be forgotten. It is a splendid opportunity for Carranza and his supporters to demonstrate the sincerity of their loudly proclaimed patriotism and build up their nation to the position to which their wonderful natural resources justly entitles it. In this they will have the hearty coöperation of the American people, who really, as a whole, ask no more than a square deal as regards their many investments, and

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who are more than willing to furnish capital for development purposes if they can be guaranteed protection for themselves and their employees.

RESULTS obtained through the investigation of the affairs of the United Railroads by the California Railroad Commission would indicate that the Company has earned the title of the 'New Haven Railroad of the Pacific Coast.' According to the statement by Mr. Mason B. Starring, president of the holding company, Mr. Calhoun was not authorized to withdraw the funds of the Company other than for its own use. It seemed serious enough when the Commission discovered a shortage of $1,096,000, but now it appears that, as usual, the worst was yet to come, for recent figures compiled by Mr. L. R. Reynolds, auditor for the Commission, show an additional amount unaccounted for of $2,486,909, thereby making a total deficit of more than three and a half millions. Efforts are being made to ascertain whether the Solano farms project possesses sufficient merit to warrant hope that a portion of the money may be recovered, but on this score everybody concerned seems non-committal; the money is gone, a dividend is due on the first preferred stock on August 15, and no funds are available for the purpose. The absence of the Company's books prior to 1910 has necessarily hampered any work of investigation, and Mr. Jesse Lilienthal, now president of the company, has a difficult task before him.

SAN FRANCISCO'S success thus far in the operation of the municipal street railways would indicate that the prospect of the city taking over the properties of the United Railroads is the only way whereby the City can obtain satisfactory service. A plan has been suggested and tentatively approved by the Company whereby the City can take over the railroads without issuing any bonds and pay for the property out of earnings. The first step will be an appraisal of the physical property and franchises of the Company. It is proposed to pay to the Company the sum called for by this appraisal, giving a guarantee of interest at a reasonable rate. The City will then operate the railroad, making all extensions and betterments on its own account. A charter amendment will have to be put through in order to make this possible. Some such plan will have to be undertaken, as the Company seems to have exhausted its credit and ability to finance improvements necessary to a rapidly growing city.

LOS ANGELES seems about to go into the power business. As predicted in these columns at the time the aqueduct power bonds were approved by the voters, the initial step has been taken by the City toward the acquisition of a city distribution system. The City has introduced at a joint meeting of the Board of Public Service Commissioners and the City Council, a resolution to acquire, either by purchase or condemnation the distributing system of the Southern California Edison Company. The resolution makes it incumbent upon the Company to sell to the City at a valuation to be fixed by the California Railroad Commission. Those in touch with the situation seem inclined to believe that the Southern California Edison Company will not receive this proposal with open arms, and that they would prefer condemnation proceedings to direct negotiations with the city officials. It would appear obligatory for the City to purchase the privately owned system and at a fair valuation rather than be guilty of such an economic blunder as to parallel a system already in use and giving adequate service.

IN San Francisco it appears likely that at last the City and the Spring Valley Water Company are going to agree upon a valuation for the Company's property without recourse to the courts. The City has offered in effect to purchase for the sum of $34,500,000 practically all of the Company's property, pipe-lines, pumping plants, and distribution system, and excepting certain lands which are not essential for watersheds. The money now impounded by reason of legal proceedings with regard to rates is to be divided equally between both parties. The Company has informed the Advisory Water Committee that it will accept the terms if they are offered by the Board of Supervisors. A special meeting of the Board of Supervisors will be called for the consideration of the matter, and a vote will be taken to act upon the proposal. The next step will be the call for an election to provide a bond issue in payment. As this is almost an essential part of the complete Hetch Hetchy project and of paramount importance to the future growth of San Francisco, it will be a relief to all concerned when final disposition of the entire matter is made.

NOW that sea-going freights are threatened with a complete tie-up owing to the war in Europe, representatives of labor were threatening the usual summer strike among operatives of all Western railroads. Conditions were very serious, and for a while it appeared that a general strike could not be averted, but President Wilson intervened and is using his good offices in the interest of industrial peace. The Federal Board of Mediation and Conciliation will have the matter in hand, and it is reported that the railroad employees have already accepted in principle the plan presented by the Board. It is proposed to restore schedules in effect prior to October 1913, with certain amendments and rulings, and submit to arbitration the question of wages. A general strike among railroads would be a disaster indeed at a time such as this when ocean carrying freight is at a standstill. It is a matter of vital interest to the country as a whole that transportation facilities be uninterrupted and that nothing impair the local markets for the products of our farms and manufactories. The various railroads involved, as was to have been expected, viewed the matter in a patriotic light and have agreed to arbitrate.

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Reinforced Concrete Poles for San Francisco Municipal Railway

By JOHN S. MARTIN*

A rapid stride toward permanent construction has been taken by the city of San Francisco in the installation of reinforced concrete trolley poles for the extension to the Municipal Railway System. Two hundred and fifty-nine of these poles have been erected on Van Ness avenue, and seven hundred and thirty-six more are being placed along Chestnut street leading to the entrance of the Exposition grounds, along Stockton street, Potrero avenue, and other extensions to the present lines.

Municipal ownership of railways has proved financially successful in San Francisco, and because of the permanent construction used in all branches of the work, the upkeep cost will be light and the profits correspondingly high. Great care is taken in the concrete construction of buildings, reservoirs, poles, etc., and the cement-gun is an important factor in this work. A dense, homogeneous mass of cement mortar is applied to the concrete walls of the buildings, reservoirs, and poles, primarily as a finish, but in reality this cement-gun mortar makes a perfect bond with the concrete, fills in all voids, and gives an absolutely water-tight wall. These results cannot be obtained by other methods.

Before going into detail as to the construction of the trolley poles, it may be interesting to note some of the cement-gun work that has been done for San Francisco. The Mission Viaduct was coated with ¼ in. of this so-called 'gunite'; all exterior and interior concrete surfaces of the municipal incinerating plant, including the 152-ft. concrete chimney, were finished by means of the cement-gun process; concrete walls were made water-tight on the 750,000-gal. Jones-street tank, the dividing wall of the Twin Peaks reservoir, the foundations of the new City Hall, the Geary-street car-house, and the water tanks for Pumping Station No. 2. At this station the flues were built of 'gunite' shot to a thickness of 2 in. on Trusset metal, and these have given entire satisfaction for the passage of gases at a temperature of 600° Fahrenheit.

Fig. 1 shows the design of the concrete trolley poles for Van Ness avenue. There are two hundred and thirty-six 'standard' poles which measure 31 ft. 2 in. over all, and taper from 14 in. square at the base to 9½ in. square at the top. In addition to these, there are twenty-three 'strain' poles which measure 31 ft. 8 in. over all, and taper from 2 ft. 4 in. square at the base to 11 in. square at the top. All poles have a ⅞-in. chamfer on the four corners.

Rows of wooden forms were built in a level lot secured by the contractor for this work. These forms were constructed of good sound lumber of correct shape and dimensions, of sufficient strength and so braced that they maintained proper shape and position against the placing and ramming of concrete dur-

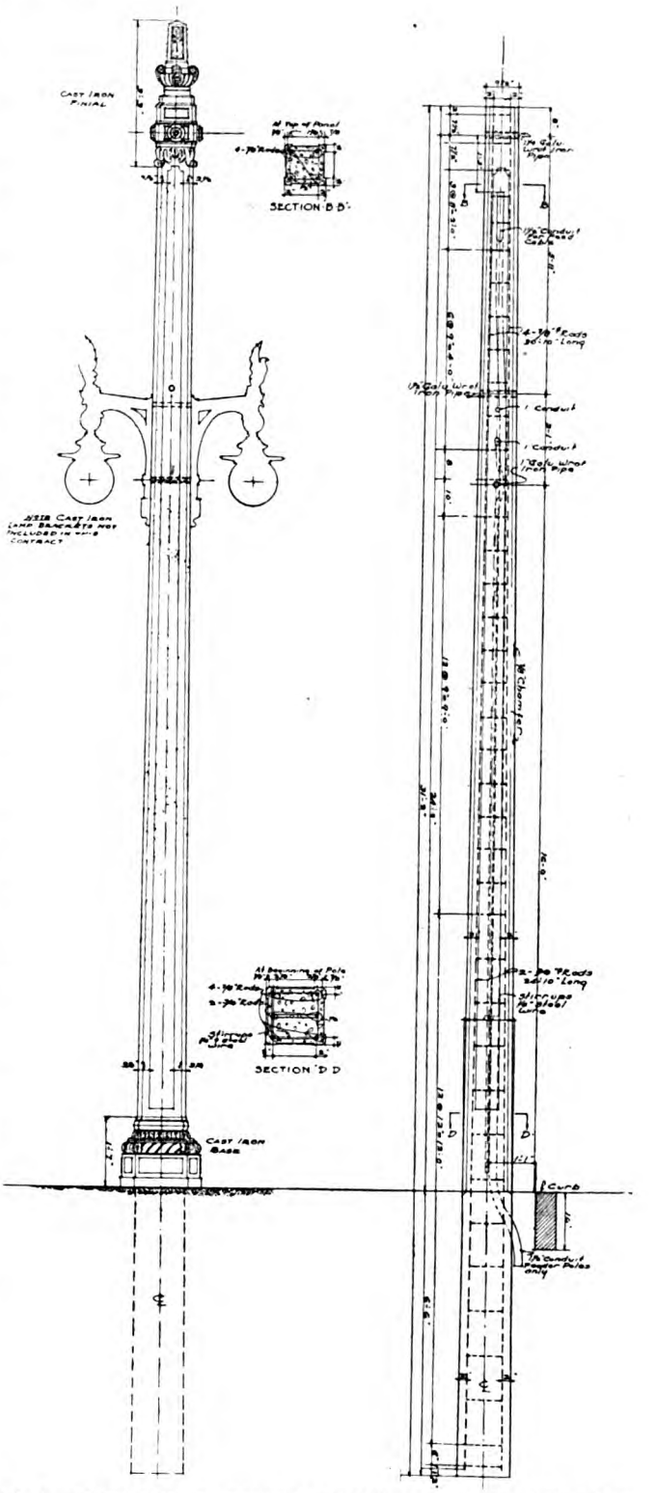

FIG. 1. ELEVATION OF REINFORCED CONCRETE TROLLEY POLES SHOWING REINFORCEMENT.

*President Martin Cement Gun Co., San Francisco.

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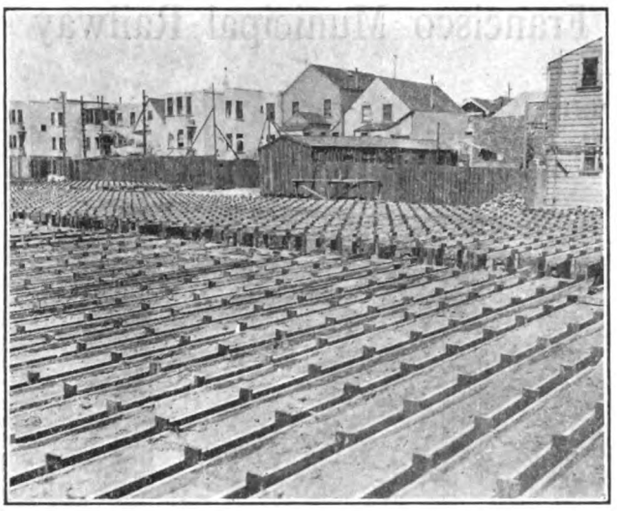

FIG. 2. POLES CURING IN FORMS.

ing the progress of the work. All boards coming in contact with the exposed concrete were sized to a uniform thickness and the edges were jointed so as to make the forms substantially water-tight, with the rough side next to the concrete. All forms were thoroughly braced and tied together so that the pressure of the concrete or the movement of men, machinery, or materials could not throw them out of line, and were so constructed that they could be easily removed without injury to the concrete. Before placing the concrete, the forms were thoroughly cleaned and wet down with a hose and running water. The steel used for reinforcing was ¾ in., and ⅞-in. bars having net section areas of 0.56 and 0.77 square inch respectively. These were accurately shaped, bent, assembled, banded together, and placed in the forms as shown in Fig. 1.

'Galvanite' conduits were placed in the poles for lighting and feeder cables. Two hundred and nineteen 'standard' and twenty-one 'strain' poles contain two 1-in. conduits, and seventeen 'standard' and two 'strain' poles contain two 1-in. and one 1½-in. conduits, all placed as shown. The concrete used was composed of portland cement, sand, and broken rock, in the proportions of 1 cu. ft. of cement, 2 cu. ft. of sand, and 4 cu. ft. of broken rock. This concrete was mixed by a machine, poured into the forms, and thoroughly tamped. No greater quantity of concrete was prepared than was required for immediate use. All fresh concrete was protected from the weather by a wet sand topping, and was thoroughly wet down twice daily for seven days after placing. Fig. 2 shows some of the forms into which the concrete had been poured. The forms were removed not sooner than thirty days after pouring, and were cleaned before using a second time. Any voids, stone pockets, or other imperfections were satisfactorily repaired by the cement-gun while the poles were being finished.

When the forms had been carefully removed, the poles were hauled up the avenue and were lowered into the ground by means of a portable derrick. The 'standard' poles were set in the ground to a depth of 6 ft. 6 in., and the 'strain' poles were set to a depth of 7 ft. below the level of the sidewalk. The base of each pole was surrounded by 6 in. of concrete. Cast iron bases and finials were then set in place, by use of the portable derrick, and galvanized steel bolts were securely fastened in place as shown.

After the poles were erected and the finials and bases were properly set, all concrete surfaces were finished with cement mortar in accordance with the following typical specifications for gunite:

Cement Finish on Concrete

All exposed concrete surfaces of the poles shall be finished with one coat of cement mortar applied by means of a Cement Gun.

Portland Cement Finish.—All the exposed concrete surfaces shall be prepared by removing all loose material adhering thereto and by thoroughly washing with water, after which they shall be finished with cement mortar composed of 1 part portland cement, 1 part Keystone sand, and 2 parts bank sand, applied by means of a cement gun. This mortar shall be of sufficient thickness to conceal all form marks and other imperfections.

All work shall be 'rodded' in the most careful manner. All molded courses shall be accurately run in accordance with the details shown. All arises shall be clearly defined, true and sharp. All surfaces shall be practically true planes, uniform, straight and plumb, complete in every respect. The color of the finish when dry must be uniform throughout, free from spots and discolorations. If necessary, all arises must be stripped in order to be clearly defined, true and sharp.

It is rather interesting to note the above rigid specifications for cement-gun-applied mortar, or 'gunite', since there has been considerable discussion as to the ability of the cement-gun men to obtain plane surfaces and sharp true angles and arises. It may be well to state here that the many advantages of gunite lie entirely in the method of application, and when once applied, cement-gun mortar is rodded up, floated, stippled, or gun-sprayed to suit any requirements for finish.

The concrete poles along Van Ness avenue were

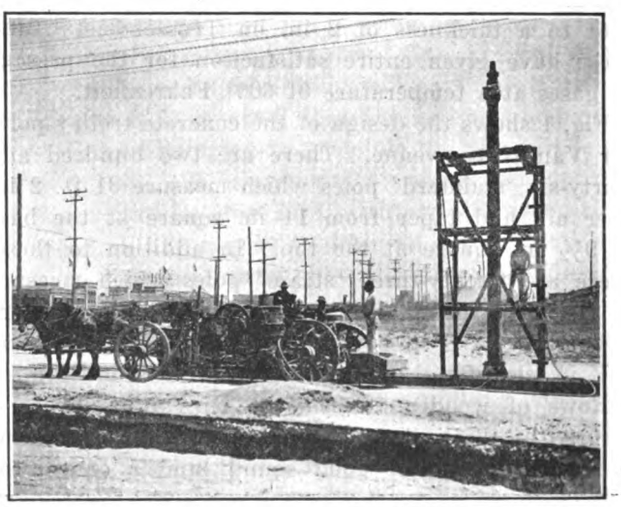

FIG. 3. CEMENT GUN OUTFIT MOUNTED ON TRUCK.

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spaced four to the block on either side of the street from Market street to Bay Point, a total distance of thirty-two blocks, or two miles. From this layout it can readily be seen that it became necessary to change from the usual cement-gun equipment. This consists of a 'gun' with its hose, nozzle, etc., and a portable gas-engine or motor-driven compressor capable of furnishing 135 cu. ft. of free air per minute at a pressure of 40 lb. per square inch. Such an outfit is entirely satisfactory for most work, as one or two setups are sufficient to do an entire job. However, with the poles, it was a case of shift from pole to pole, and each shift meant moving the gun, compressor, materials, and scaffold.

Fig. 3 shows one of the two outfits that were rigged

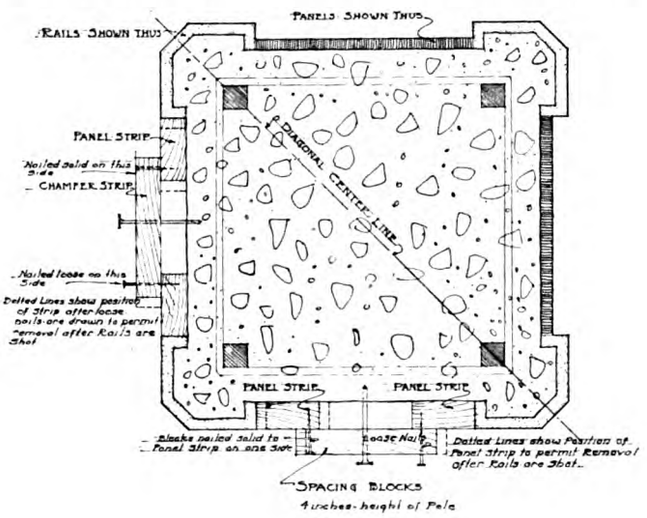

Fig. 4.

especially for this job. A gas engine-driven compressor was mounted on the forward end of a large dray and securely bolted in place. The gun was placed just back of the compressor and securely fastened down, and the necessary hose connections were made between the two machines. Water was carried in two 110-gal. drums placed on either side of the outfit, and by means of a small air-driven Worthington pump was circulated through the compressor and through the nozzle line. A small material box was built in the end of this outfit, and then with the aid of a team of horses, the compressor, gun, hose, nozzle, water, and material were moved in one operation.

Fig. 4 shows a typical cross-section of the concrete poles. The most difficult feature of this work was producing the sunken panel with its sharp, true angles and arises. As can be seen, there are eight angles and sixteen arises on each pole which were brought out in the following manner. A set of collapsible wooden strips were made to fit in the sunken panel. These strips, as shown in Fig. 5, consisted of two strips, M and N, milled to taper and size, and fastened together by means of a third strip R that was securely fastened to M and temporarily fastened to strip N by means of eight-penny nails. These panel strips were put in place and then secured by means of so-called 'concrete' nails, which are 2-in. galvanized roofing nails.

The gun outfit was then brought up to the stripped pole and a coating of gunite was applied to the 'rails' or four corners. Fig. 6 shows the nozzleman performing this operation. By means of a template cut to fit the rail and to ride on the panel strips as shown in. Fig. 5 and 7, the next operation was greatly simplified. When this template was drawn over the gunite from the top to the bottom of the pole, the four arises on each rail were cut true and sharp in one

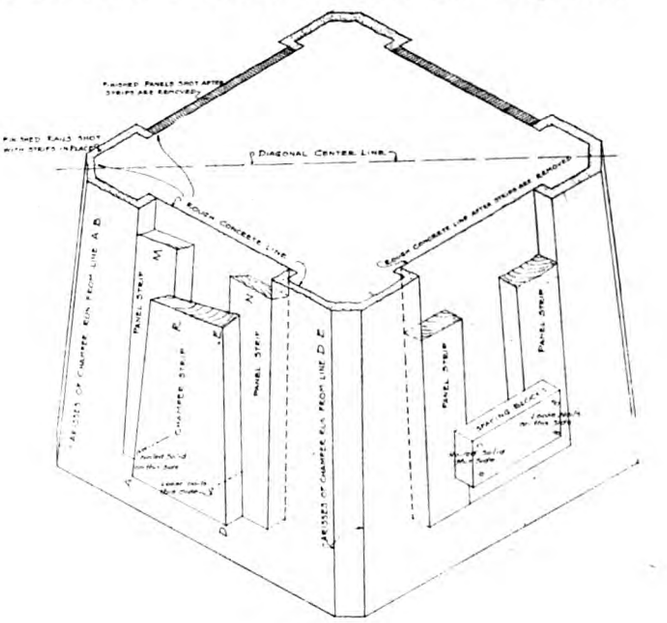

Fig. 5.

operation. The man following behind the template touched up the work and floated it to a smooth surface.

These rails were permitted to set over night, and the next morning, while additional poles were being 'shot,' the nails were pulled from strip R on the strip-N side, and the panel strips were thus easily removed. In this way the two angles of each corner were left true and sharp, and no additional work was necessary as this left the angles and arises complete in every respect. After the panel strips were removed, the outfit was hauled back to the pole and the panels were shot and floated, as shown in Fig. 8. A small amount of detail work was necessary under the finial and base, and when this was done the pole was completed and the staging was shifted to another pole. The staging was built in two sections and was thus easily assembled and torn down to move from pole to pole. A canvas curtain was hung on the staging as a preventive against public injuries that might have been caused by the flying sand. High winds caused excessive blowing away of the material as it was shot from the nozzle.

Each pole required only 9 cu. ft. of mixed material, and because of the constant shifting it was necessary

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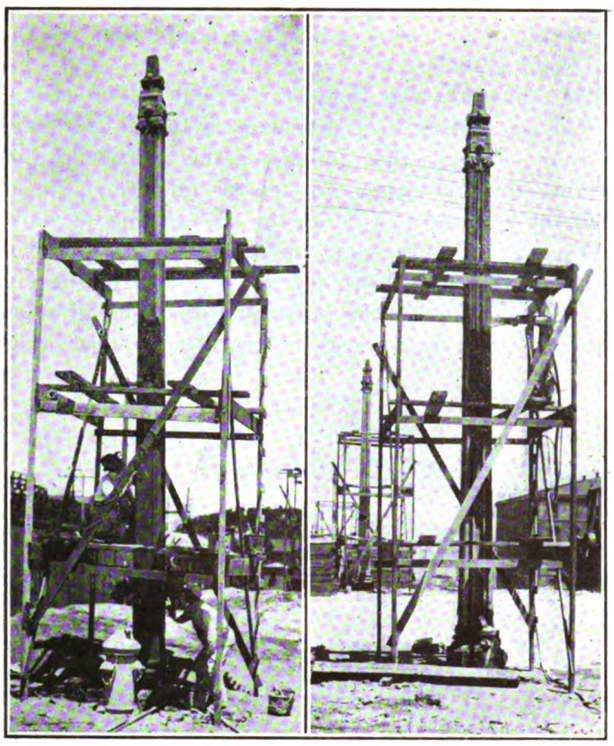

FIG. 8. FIG. 6.

to scatter the material out over the job at intervals of four blocks. From these stations the hod-carriers wheeled the material to the box on the outfit. Another hod-carrier stayed with the 'gun' to load the material into the hopper and to move the hose and nozzle.

There were two 'gun' outfits employed in this work, each having a crew of four men, the nozzleman, hod-carrier, engineer, and teamster. The operation of shooting the 'rails' required about 20 minutes, and shooting the panels took about 11 minutes. The 'follow-up' crew consisted of sixteen plasterers and two foremen, and this crew finished sixteen poles per day. Two men finished the 'rails' on one pole in 2 hours and 15 minutes, and the panel in 1 hour and 45 minutes. In this way, the average was a pole to the man per day.

After the gunite had been kept thoroughly wet down for one week, each pole was painted with two coats of 'Concreto' cement paint, and the bases and finials received three coats of lead and oil. The color chosen was a cream yellow, and the general effect is very pleasing.

Cost Data*

Average cost per pole including contractor's profit.

Forms, including labor	$12.00
Reinforcing steel, including labor	18.00
Conduits, in place	6.50
Concrete, in place	10.50
Cast iron bases and finials and eye-bolts, in place	25.00
Erecting, back-fill, repairs to sidewalk	22.00
Hauling	3.00
Painting	3.50
Cleaning streets	1.50
Scaffold material	0.48
Scaffold labor	1.56
Cement (for gunite)	2.16
Sand (for gunite)	0.46
Water (for gunite)	0.10
Mixing labor	1.50
Panel strips	0.40
Labor and teams for shooting	8.66
Labor of 'follow-up' crew	9.20
Cleaning street	0.50
Gasoline, oil, supplies	0.50
Hose	0.48
Total cost per pole	$128.00
Cost of 'Gunite' per pole	$26.00

*Cost data furnished by H. S. Tittle, general contractor.

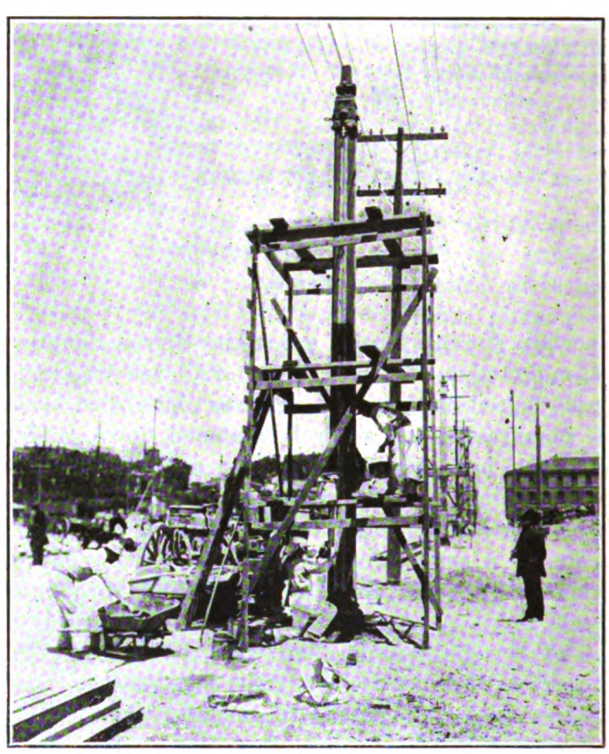

FIG. 7.

The Prussian regulations for the design of reinforced-concrete structures were revised on April 22. The permissible unit stress of steel in compression and tension was raised from 14,000 to 17,000 lb. per square inch. The reason given for the increase is that the steel is rolled to such small dimensions as to increase its strength materially. The tensile strength for ⅜-in. bars should be at least 60,000 lb. per square inch, and for 1 $\frac{3}{16}$-in. bars 54,000 lb. Intermediate values are derived by straight-line interpolation. With these values the elastic limit must be not less than 0.6 and not more than 0.7 of the ultimate strength. The elongation must be at least 25%. For cold-bending tests the diameter on the inside of the bend shall be equal to half the thickness of the bar, and it is further specified that no cracks must develop under these conditions.

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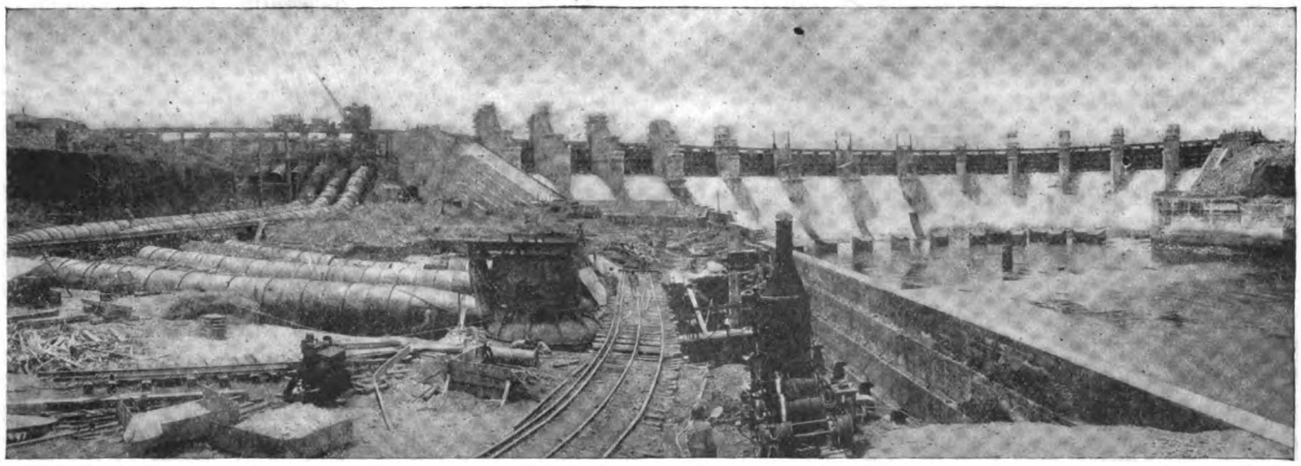

PANORAMIC VIEW OF GATUN HYDRO-ELECTRIC INSTALLATION UNDER CONSTRUCTION.

Gatun Hydro-Electric Development for Panama Canal*

The permanent supply of electric energy for the Panama canal is generated in the Gatun hydro-electric station, which is situated at the Gatun spillway dam. The tremendous water storage in the artificial Gatun lake, fed by the Chagres river, not only carries vessels the greater part of the way across the isthmus on a level about 85 ft. above the oceans, and provides water for raising and lowering them gently through the Gatun, Pedro Miguel, and Miraflores locks, but it also has afforded an excellent opportunity to generate electric current for lighting the canal, for operating the gigantic gates and other locking machinery, and for the locomotives towing ships through the locks.

Electric current will likewise be used for coal-handling plants at both ends of the canal, for machine-shops, water works, dry-docks, and possibly in the future for hauling trains on the Panama railroad. To insure continuity of service in case of accident, a steam-electric station at Miraflores, erected a few years ago to supply power for construction work, will be ready to pick up the load when necessary.

Brief Data on the Canal

The extreme length of the canal is about 50 miles, it has a minimum depth of 41 ft., and the channel varies from 300 to 1000 ft. wide. The famous Culebra cut has a length of about 9 miles. The crest of Gatun dam has a length of 8000 ft. and an extreme width of 2100 ft., the height above the normal lake-level being 30 ft. There are three double sets of locks at Gatun, one double set at Pedro Miguel, and two double sets at Miraflores. The average lift of each set is 28½ ft., the length of each chamber being 1000 ft. and the width 110 ft. The time required for the passage of vessels through the locks is about 3 hours, and through the canal from ocean to ocean 8 to 10 hours.

*From data furnished by the General Electric Company.

The width of the Canal Zone is 10 miles, and it has an area of 436 square miles. More than 40,000 men have been employed in building the canal, and over 200,000,000 cu. yd. of earth has been excavated. It is estimated that $375,000,000 will represent the total cost of this mammoth project.

Power and Distribution Equipment

The complete equipment for the power and distribution system on the canal comprises the 7500-kva., 2200-volt hydro-electric power-plant at Gatun; the 4500-kva., 2200-volt Curtis turbo-generator electric power-plant at Miraflores for emergency; a double 44,000-volt transmission line across the Isthmus, connecting Cristobal and Balboa with the two power-plants; four 44,000-2200 volt sub-stations, stepping down at Cristobal and Balboa, and up or down at Gatun and Miraflores, depending on which of the two plants is supplying power; thirty-six 2200-240 volt transmission stations for power, traction, and light at Gatun, Pedro Miguel, and Miraflores locks; three 2200-220-110 volt transformer stations for the control boards at the locks; and stations at Cristobal and Balboa for the coal-handling plants, machine-shops, and dry-docks.

The Gatun hydro-electric station has a capacity of 6000 kw.; and provision has been made to increase this to an ultimate capacity of 12,000 kw., should this amount of power be required later for the operation of the Panama railroad, the three outlet pipes in the dam having been installed along with the original pipe-lines.

Operating Head and Intake

The gross head available from Lake Gatun to mean tide level of the Pacific ocean varies from a maximum of 91 ft. in the extreme flood times to a minimum of 79 ft., to which level the lake may possibly drop toward the close of the dry season. The plant is designed con-

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sequently to develop the full water output when operating under an effective head of 75 ft. For three or four months of every year there is absolutely no rainfall on the Isthmus; and during this period, it is desirable to conserve the water to as great an extent as possible. Maximum efficiency was therefore demanded for the apparatus of both the waterwheel and generator manufacturers.

Water is taken from Lake Gatun through passages 12 ft. wide, fitted with wrought iron racks 29 ft. 7 in. high to prevent trash from entering the pipe-lines. The water is admitted into the pipe-lines through three 10 ft. 6 in. diameter head gates. These gates are of massive cast iron construction, the seats where water tightness is required being made of bronze.

Details and Operation of the Gates

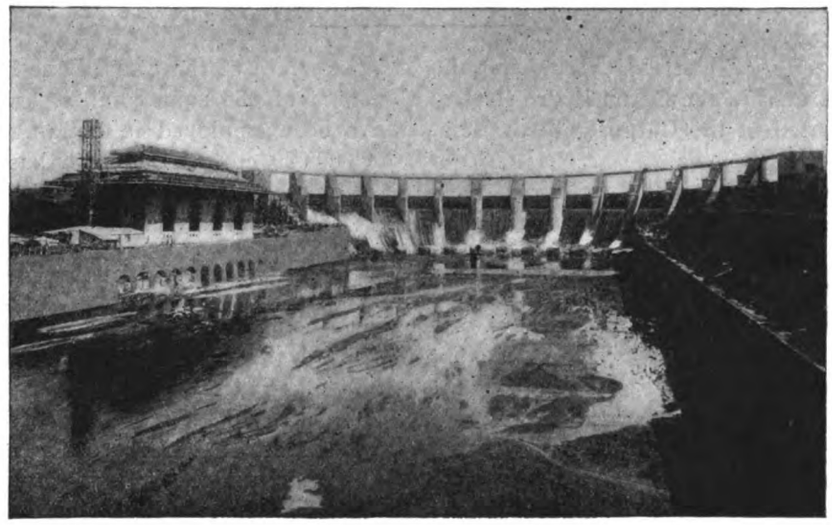
Each gate is equipped with two steel stems for raising and lowering. These stems are fitted with bronze nuts working in roller thrust bearings, and the nuts are fitted with steel bevel gears arranged to be operated by a 15-hp., 220-volt, alternating current motor with a speed of 750 r.p.m. The motor is placed between the stems and has shaft extensions on each side that carry two bevel pinions arranged to engage the bevel gears on the stem nuts. The stands which carry the stem nuts are equipped with hand-operating mechanism, arranged to be disconnected when the gate is operated electrically.

The gates are equipped with automatic control devices, consisting of a limit switch geared to one of the gate stems and a float switch actuated by the water in the pipe. The action of the control is as follows, the gate being closed and the pipe-line empty: At the power house, the gate motor switch is closed which starts the motor and begins opening the gate. When the gate has opened a sufficient distance to fill the pipe-line in about five minutes, the limit switch opens the circuit and stops the motor.

The gate remains in this position until the pipe-line is filled and the water rises in the 36-in. diameter air vent just below the gate, when it actuates a float switch and again closes the motor circuit, thereby causing the gate to be opened fully, when the limit switch again operates to prevent over-travel. The gate is closed by reversing the main switch at the power house, which causes the motor to operate, the limit switch again stopping the motor when the gate has reached the closed position. In case the electric power should fail, the gates can be hand-operated by two men.

The Intake Pipe-Lines

Each of these gates is bolted to a pipe-line 10 ft. 6 in. diameter with an average length of 420 ft. The pipe-lines are made of $\frac{3}{8}$-in. steel plates in courses 8 ft. long, each course being made of three sheets to form the circumference. The centre of each course is fitted with a 3 by $\frac{3}{8}$-in. Z-bar ring, which is also made in three sections. After the pipe was riveted together at the plant, the outside was covered with a layer of reinforced concrete to prevent rust.



GATUN SPILLWAY DAM, SHOWING CREST GATES, OGEE DAM, AND BAFFLE PIERS.

The pipe-lines are led down to the rear of the power house on a uniform slope from the spillway, and are connected to the turbines in the power house through 90° bends having a radius of 70 ft. Each of the pipe-lines is arranged for attaching a Pitot tube testing apparatus while its unit is in service, and one pair of portable tubes for taking readings in planes of the pipe at 90° from each other was supplied.

This is accomplished by fitting each pipe with two 6-in. saddle nozzle connections 45° on each side of the vertical centre line of pipe. From these connections there are two Pitot tube supports placed across the pipe at right angles to each other with their thin sections pointing in the direction of the flow of water and fitted with guides for the Pitot tubes. These supports are bolted in the pipes and, while they are intended to be permanent, can be removed very readily.

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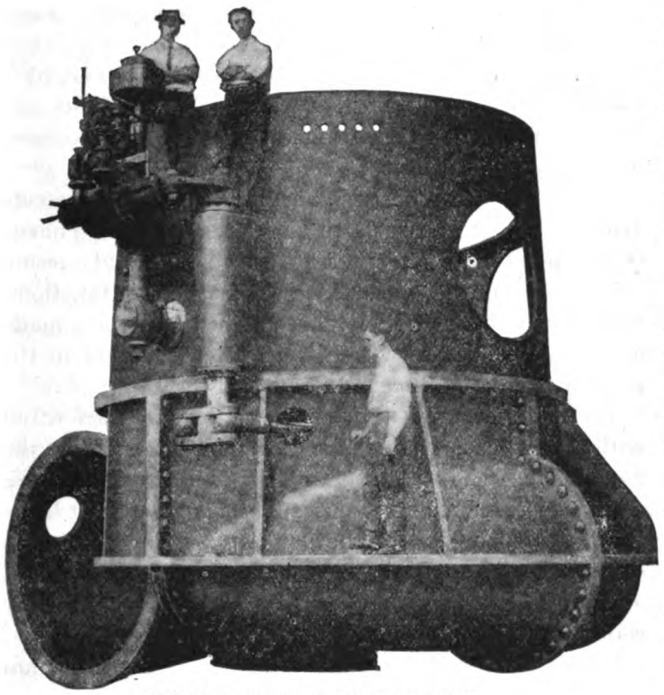

3600-HP. PELTON FRANCIS TURBINE.

Each 6-in. outlet on the pipe is closed by a gate valve with tongue and groove flanges that match the base on the Pitot tube apparatus. Each Pitot tube is arranged to measure both the static and velocity heads at practically the same point in the pipe, and readings are obtained by means of 'U' tubes containing a colored liquid having a specific gravity of about 1.25. Carbon tetrachloride thinned with gasoline to the proper specific gravity and colored red is usually used for this purpose.

One end of each 'U' tube is connected to the static and the other to the velocity side of the Pitot tube, and the difference in height of the colored liquid columns read, from which the velocity of flow in the pipe is calculated. This form of Pitot tube is very simple and reliable, as it does not require compressed air to keep the head within readable limits and, at the same time, the difference between the static and velocity heads is read off directly.

In order to measure the flow in any pipe-line, it is only necessary to bolt the Pitot tube base plates to the valve flanges and open the gates, when the tubes can be pushed into the pipes and readings taken. When the test is completed, the Pitot tubes are withdrawn until they clear the gates; then the valves are closed, and the apparatus can be removed.

The Gatun Hydro-electric Station Building

The principal buildings connected with the actual operation of the canal are the hydro-electric station at Gatun spillway; the gate control house at the spillway; the four substations of the transmission system at Gatun, Miraflores, Cristobal and Balboa; and the three lock control houses. All these structures are designed along simple lines in harmony with the unbroken surfaces of concrete of the adjacent engineering works, and for the same reason are devoid of all modeled ornament; the plain wall surfaces are relieved only by the restrained mouldings of the bases and cornices, and architraves bounding the openings. This has the effect of enlarging the scale, or apparent size of the buildings, though they appear dwarfed by their proximity to the large masses of concrete.

The hydro-electric station measures 61 by 137 ft. and has an extreme height of 74 ft. The building is designed on the unit principle, to admit of future extension, and consists of a single room open to the roof, exposing the trusses upon which is laid the reinforced concrete roof slab, which, in turn, receives the red Spanish tiles. The walls are of poured concrete, 30 in. thick to the level of the crane rails, near the cornice. The exterior overhang of the main roof is 13 ft. 2 in. and that of the monitor roof 4 ft. 8 in., the exceedingly large projections having been generally adopted for all the permanent buildings in the Zone as a shelter from tropic rains, as well as from the heat of the sun.

Beyond the general use of tile for flooring, and an interior white enameled brick wainscot 14 ft. high, to relieve the coarseness of the walls, there is no difference in the finish of the concrete surfaces within and without. The dead surfaces of the concrete or stuccoed walls, which will probably be improved when weathered, are further relieved on the exterior by the red tile roofs. The principal ornamentation is on the under side of the broadly projecting cornice, which is broken into paneled coffers. A number of these contain light outlets that cast light down on the walls and throw the structure into strong relief at night. The large glass surfaces are attractively broken into smaller panes. Little wood is used anywhere, but for economy it is utilized in the large side frames and sash, the end frames and sash being of iron.

The interior has four principal elevations; namely, a pit for the three 2500-kva., hydro-electric turbines, a main floor, and two galleries. The turbine pit, with an area of over 2100 sq. ft., is situated 6 ft. below the level of the main floor and is reached by iron stairways descending alongside the turbines. From the pit, other stairs lead down to the storeroom on the north side, and to the air-compressor and oil pump compartments at the ends. The pit is lined with white enameled brick, which is both attractive and clean. The 14-ft. wainscot extends from the main floor up to the first gallery elevation on the south wall of the pit.

Intermediate between the pit and the main floor, and reached by stairs from the latter, are toilets in the southeast corner of the building, giving separate accommodations for white and colored employees. The walls are treated in enameled brick, similar to the turbine pit, and the rooms are equipped with modern fixtures and separate shower compartments.

The main floor divides into two parts, one being partitioned off and devoted to the use of the electrical equipment, and the other forming an uninterrupted

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passage on the longitudinal axis of the building, terminating with two large entrance doors at either end. Easy access to railway cars is afforded by means of a track which enters the floor from grade through the northwest door, thus giving every facility for handling heavy machinery by the 30-ton electric crane running the length of the building overhead.

Concrete stairways at either end of the building give access to the mezzanine and second galleries, which are devoted to the switchboards, oil switch compartments, reactance coils and other electrical equipment. Two such galleries extend the entire length of the station on the northeast side, and in the south corner are superimposed two smaller ones used as a machine shop and an office respectively. The sash in the large side wall windows are operated in sections by a hand gear system, and the continuous bottom hinged sash in the roof monitor are operated by motors.

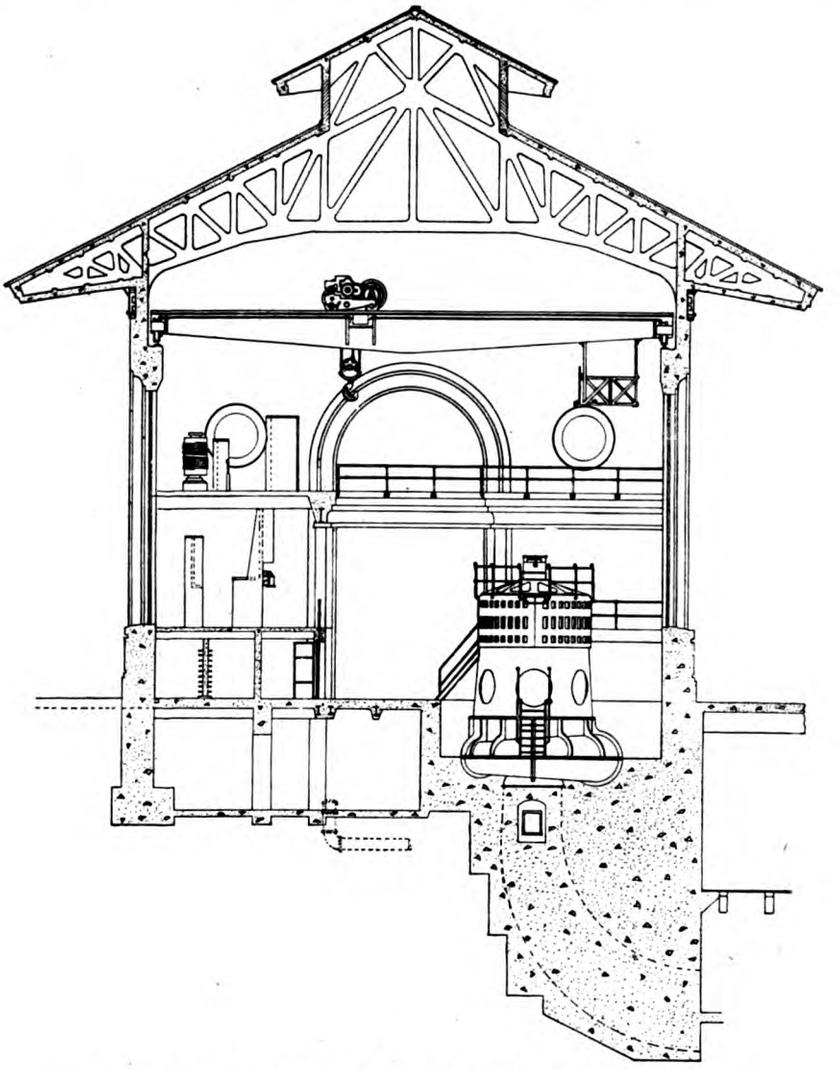
The Three Francis Turbines

The three 2000-kw. main generating units in the hydro-electric station are each driven by a special, 50-in., vertical, single runner, Francis turbine manufactured by the Pelton Water Wheel Company. Each turbine has a maximum capacity of 3600 hp. when operating under an effective head of 75 ft. and at a normal turning speed of 250 r.p.m. The turbines are situated at such a height that the centre of the runners is 20 ft. above tail water.

The water is discharged through steel lined concrete draft tubes, which are 71-in. diameter at the discharge from the runners and increase to an elliptical section 9 by 17 ft. at the outlets, which are horizontal, there being a 90° bend in the tubes. The linings are made of ¼-in. steel plates, which were fitted together in the shop and shipped knocked down.

The turbines are of the spiral case type and are fitted with heavy cast iron distance rings which carry the generators. The weight of the revolving parts of each generator and turbine is carried on a roller thrust bearing mounted on top of the generator. The turbine is so designed that the runner exerts an upward thrust of 20,000 lb. when working at full capacity, thereby relieving the thrust bearing of that amount of load.

Oil for the thrust bearing is supplied by a small pump geared to the main turbine shaft, and a tank is pro-



CROSS-SECTION OF POWER HOUSE, GATUN HYDRO-ELECTRIC INSTALLATION.

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vided below the pump to receive the overflow from the bearing. In this way a constant circulation of oil is maintained. As the oil returns to the suction tank, it passes through the lower guide bearing on the main shaft and lubricates it.

The runners of the turbines are made of a special bronze and weigh approximately 7000 lb. each. They are bored taper and held in place on the lower end of the shaft by means of bronze nuts. The surfaces of the runner vanes are all hand finished to reduce hydraulic losses.

The Governors

The speed of the turbines is controlled by Pelton oil pressure governors, which are mounted on the distance rings and are driven by bevel gearing from the main shaft. Tachometers are mounted above the governors on supports bolted to the distance rings. The tachometers are directly connected to the governor heads.

The governors are fitted with small electric motors for varying the speed of the main units for synchronizing purposes, and a device is provided on each governor for varying the permanent drop in speed from no load to full load. This can be adjusted for any variation from 5% drop to absolutely constant speed from friction load to maximum load. The governors are also fitted with hand control mechanism for adjusting the gates independent of the oil pressure.

The wicket gates for controlling the supply of water to the runner of the turbine are steel castings with hand finished surfaces. Each gate has its pivot stem extended upward through a packing gland and is fitted with an operating lever. All the gate levers are connected to the gate ring by means of bronze links, and the gate ring is connected to the governor rockshaft. All the regulating mechanism is therefore outside the turbine case, except the gates themselves. The water passages on each side of the gates are provided with renewable rolled steel wearing plates.

The pressure oil for actuating the governors is supplied by two Pelton rotary pumping units, driven by 10-hp. alternating current motors at a speed of 375 r.p.m., each pump being capable of supplying the governors on all three units. The governors work on an open system, there being no vacuum chambers used. The discharge oil from the governors is led into oil sump tanks, from which it passes into the suction of the pumps. Each oil pump is connected to a steel pressure oil receiver with an air space above the oil. The oil sump tanks and pipe connections are installed in duplicate and valves are provided to enable one set to be cleaned while the other is in service.

Generators and Direct Connected Exciters

The three main generating units are of the vertical revolving field type, each being provided with a direct connected exciter. The generators are of the General Electric Company manufacture and are three phase, 25 cycle, with a guaranteed continuous capacity of 2000 kw. at 0.8 power factor, 2200 volts, 250 r.p.m., and with an overload rating of 2500 kw. at 0.8 power factor for two hours.

The exciters are of 50 kw. capacity at 125 volts, each capable of furnishing exciting current for two generators under maximum guaranteed load. Each unit, generator and exciter, weighs approximately 65 tons.

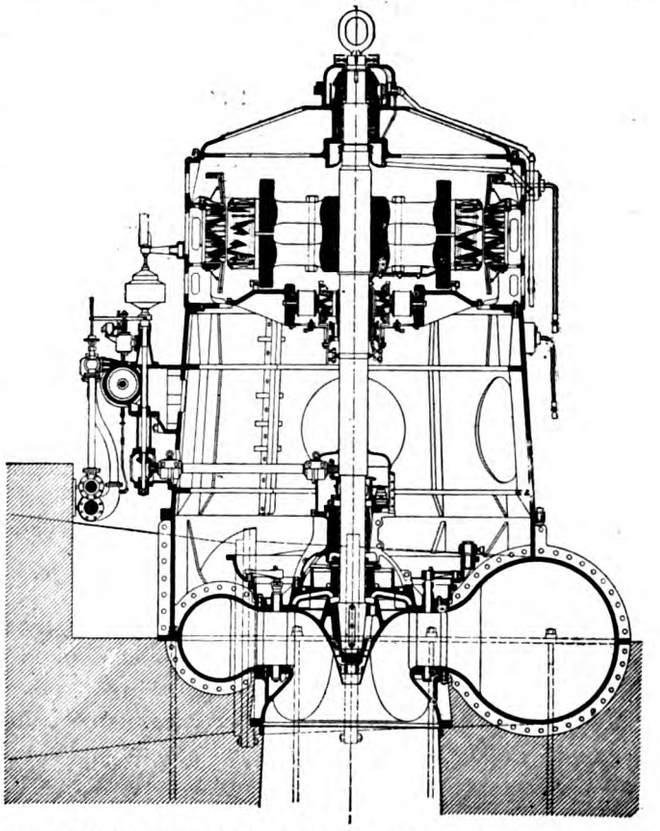
The generators are carried on heavy cast iron distance rings furnished by the Pelton Water Wheel Company, the stationary armatures being bolted to these rings. The thrust and upper guide bearing support consists of a very rigid iron casting, bolted to the top of the stationary armature.

The thrust bearings are of the roller type, manufactured by the Standard Roller Bearing Company, Philadelphia. These bearings carry the weight of the complete revolving element, consisting of the generator field, exciter armature and turbine runner, which are mounted in this order on a one-piece shaft. The weight thus suspended is 32 tons. The exciter magnet frame is supported by lugs cast on the stationary armature of the main generator.

The exciter is readily accessible through large holes in the distance ring, a platform being provided inside the ring from which the exciter commutator and generator collector rings may be reached.

Provision is made for securing the magnet frame of the exciter to the revolving element of the generator, so that the complete rotating element, together with the exciter frame, is raised at once in disassembling.

For inspection of the roller bearing, it is necessary



CROSS-SECTION THROUGH WATERWHEEL, GENERATOR, AND EXCITER.

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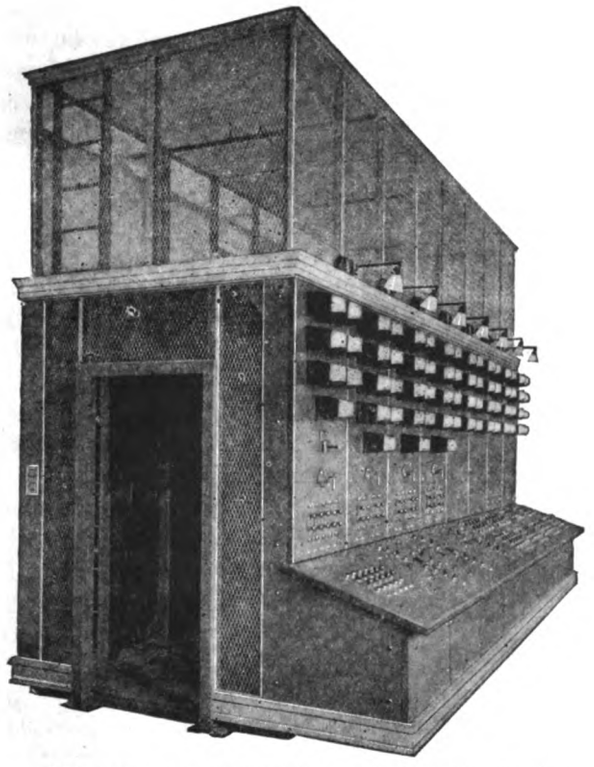


2200-VOLT A. C. INSTRUMENT AND CONTROL BOARD.

simply to remove a speed limiting switch from the top of the shaft and the upper half of the bearing housing. There are two guide bearings, one immediately below the thrust bearing, furnished with the generator, and the other above the waterwheel, furnished by the waterwheel builder. The arrangement of the complete unit is shown clearly in the cross sectional view.

The generators, under official tests, showed an efficiency of 95.1% at 2000 kw., 0.8 power factor; 94.3% at 1500 kw., 0.8 power factor; and 92.5% at 1000 kw., 0.8 power factor. The guaranteed temperature rises of 40°C. above room temperature, of 25°C. under continuous operation at full load, and 55°C. rise after two hours run at 25% overload, were met with an ample margin.

All of the apparatus was subjected to the most rigid and minute inspection during manufacture by representatives of the Isthmian Canal Commission. The insulation of all windings was made moisture proof on account of the extreme climatic conditions on the Isthmus. The revolving field was given a running test at twice normal speed in the testing pit at the factory provided for this special purpose.

Reactances

Current limiting reactances were provided to give 5% reactive drop, at 2500 kva., 2200 volts, 3 phase, 25 cycle. While the generator windings are sufficiently rigid to stand the strain of a short circuit under full load, these reactances will reduce the shock on the windings and will also serve to render the operation of synchronizing the machines easier and safe.

Motor-Generator Sets

In addition to the direct connected exciters, two motor driven exciters are supplied. These consist of a 100 kw., 125 volt, 500 r.p.m. generator, direct connected to a 150 hp., 2200 volt, 25 cycle squirrel cage type, induction motor. They are mounted on a common base plate and provided with three bearings. These exciters can also be used for charging the control battery.

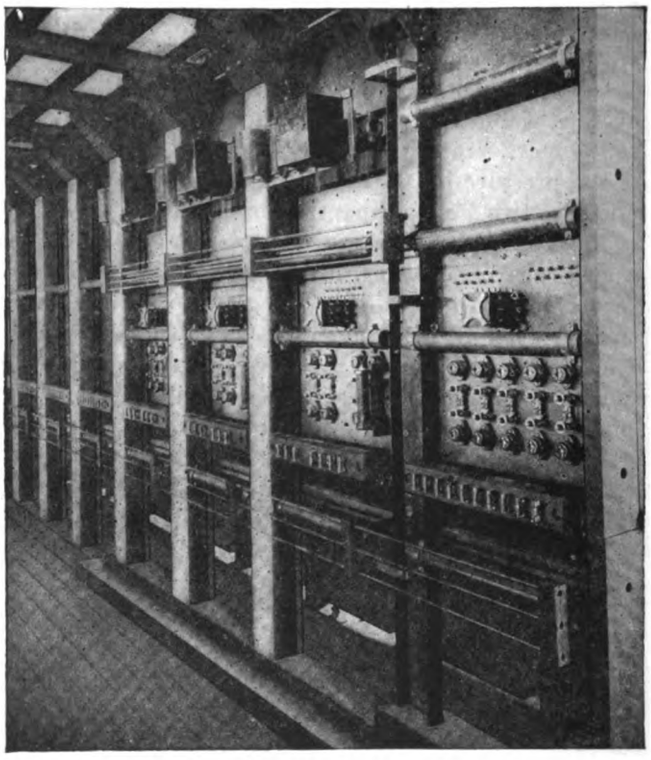
Distribution Scheme

On account of the great distance, the current is transmitted at a voltage of 44,000 from the power stations to both ends of the canal. The step-up transformers are, however, not in the power plants, but in substations in their vicinities; therefore, the power plants generate and distribute only 2200-volt current.

The system of connection throughout employs the double bus, double switch scheme, with provision for disconnecting any oil switch for cleaning or repairs without interrupting the circuit. This system was naturally selected for this station because it was considered the most flexible for the requirement of uninterrupted service, which the engineers of the Isthmian Canal Commission have so carefully considered, though without superfluous complications.

Instrument and Control Board

The main switchboard is of the benchboard type, with vertical rear board for relays, watthour meters, graphic instruments and the control battery equipment. The switchboard and all control apparatus were built by the General Electric Company. The space between the



INTERIOR 2200-VOLT A. C. BENCH BOARD.

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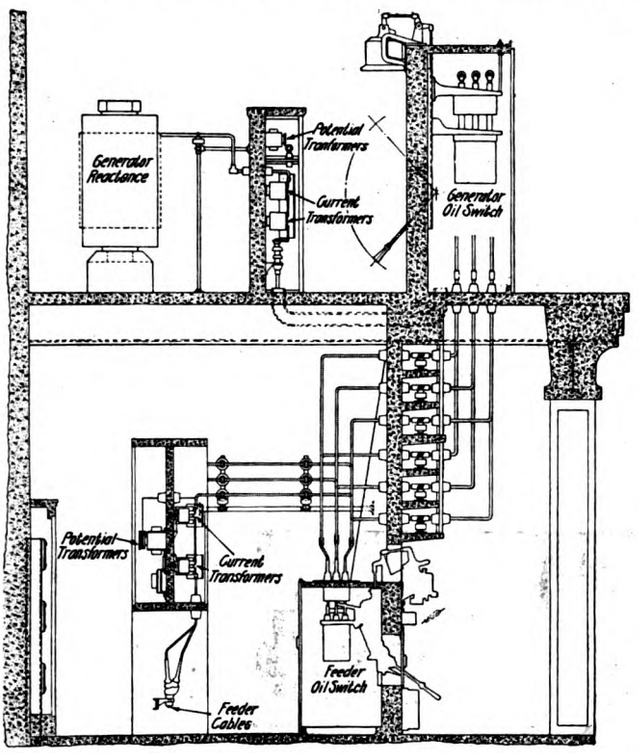
front and the rear boards is enclosed by grille work with doors at both ends, and a metal moulding extending along the floor and the top of the board gives a finished appearance to the whole. On the top of the switchboard is a second story, for the electrically controlled generator and exciter rheostats, accessible by means of a ladder inside the structure. The first panel from the left in the benchboard controls the exciters, the next three the generators, and the remaining four



ARRANGEMENT OF SWITCHING APPARATUS.

the twenty-four feeder circuits. The system of connection is represented by dummy busses of polished copper on top of the bench. The interior view of the benchboard shows the arrangement of operating busses and fuses, potential busses, instrument resistances and the channel iron risers with distributing tubes which carry the instrument and control leads to their points of connection on the board.

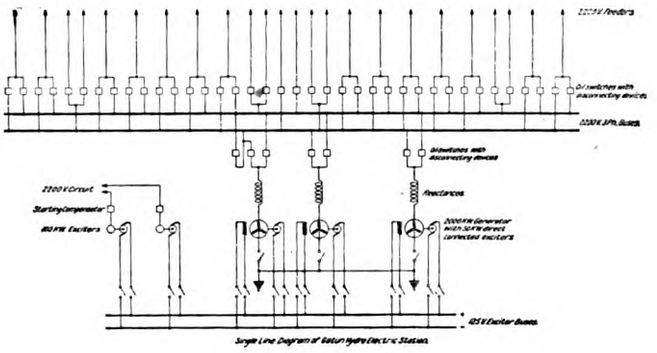
A generator voltage regulator, transferable to either of the two sets of busses, is installed on a separate pedestal which also carries the synchronism indicators and clock.

Exciter Board

As mentioned above, the exciters are controlled from the benchboard, but the electrically operated exciter switches and field switches are mounted on a separate board so as to make the exciter connections as short as possible. This arrangement eliminates the exciter busses and the main connections from the control board, but leaves the control of the whole equipment in the hands of the operator.

Bus and Switch Compartments

The bus and switch compartments are on two gal-

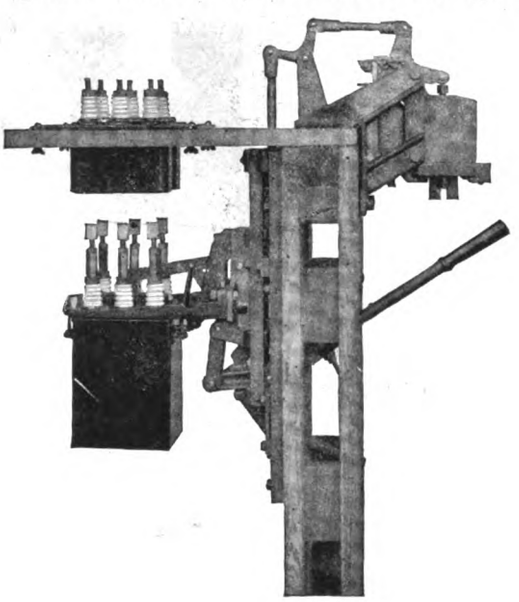


SINGLE-LINE DIAGRAMS OF STATION.

leries. On the upper gallery are the control board, near the end of the station that may be extended, the generator reactances, compartment for generator current and potential transformers, and the generator oil switches. From the oil switches, connections are made through the floor to the busses on the gallery below, on which gallery are also the feeder oil switches, and the compartment for the instrument transformers and cable bells. On the main floor just below this gallery is the cable vault with racks for the feeder cables.

All compartments are built of concrete with flame-proof doors. The busses and connections are made of solid copper rods of sufficient size to give a rigid construction even where the current is very small. After installation, the busses and connections and all joints are heavily insulated with varnished cambric to make them perfectly safe.

All the 2200-volt oil switches are solenoid operated and are provided with mechanism for disconnecting them easily for cleaning or repairs, so arranged that the live parts are completely covered. For the hand operated switches, a pipe framework supports vertical metal guides which carry the oil switch operating



TRIPLE-POLE, SINGLE-THROW, 2500-VOLT, 300-AMPERE OIL SWITCH WITH SOLENOID OPERATING MECHANISM, AND DISCONNECTING DEVICE OPEN.

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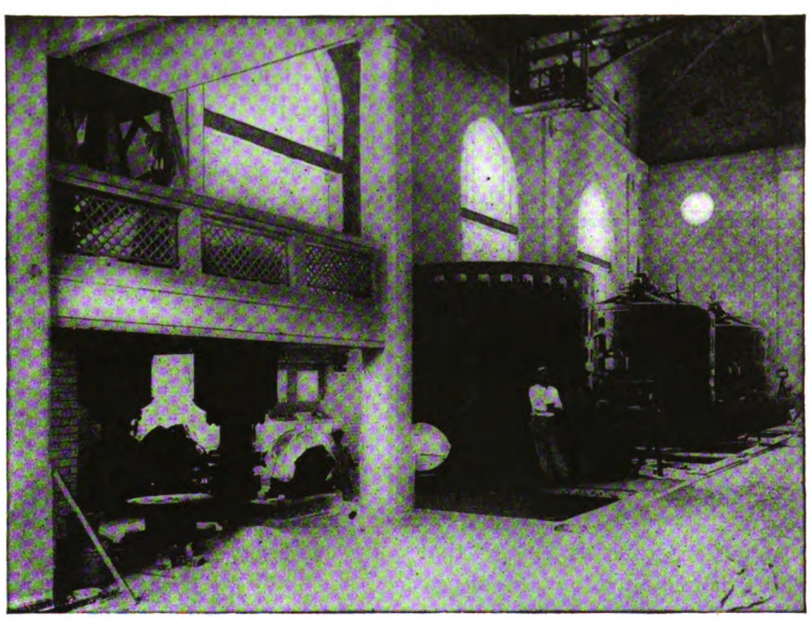
mechanism and slate base forming a section of the switchboard panel. On the guides a lever and toggle mechanism is mounted, by which the oil switch and slate base may be raised and lowered. Above the oil switch and mounted on the pipe framework a stationary cast iron base carries the disconnecting switch studs and insulators. The high tension leads run to the tops of the disconnecting switch studs, and the bottom of each stud is equipped with contact fingers. On the top of each oil switch stud is mounted a contact blade.

When the oil switch is raised, these blades engage the contacts on the bottom of the disconnecting switch studs, which thus in the closed position form extensions of the oil switch studs. The disconnecting switch contacts are surrounded by insulating shields which prevent accidental contact. When the oil switch is lowered, it is completely isolated from the circuit. When the oil switch is raised, it always goes to a fixed height where it is latched. An interlock prevents the oil switch from being raised or lowered unless its contacts are open, precluding the circuit being closed or opened by the disconnecting switch. In some instances another interlock makes two single-throw switches a double-throw switch and prevents both switches being closed at the same time.

For solenoid operated switches, the same form of disconnecting switch is used; but the solenoid is stationary, and the connecting mechanism to the oil switch has a vertical slotted link that allows the oil switch to be raised and lowered without being disconnected from the solenoid mechanism. A mechanical interlock prevents raising or lowering an oil switch while in the closed position.

The complete hydraulic equipment for this installation, including the racks, headgates, pipe-lines, Pitot tube testing apparatus, turbines, governors, and oil pumping units, was designed and built by The Pelton Water Wheel Company; and all the electrical apparatus, including the generators, switchboards, transformers, head gate motors, limit switches, float switches, accessories and motors for driving the oil pumps, was designed and built by the General Electric Company. The details of design and manufacture of all this apparatus were subject to the approval of the Isthmian Canal Commission's engineers.

The shipping weight of the material furnished by The Pelton Water Wheel Company, including the auxiliary electrical apparatus purchased by them from the General Electric Company, was approximately 1000 tons.



INTERIOR VIEW OF 6000-KW. GATUN HYDRO-ELECTRIC POWER-STATION, PANAMA CANAL.

REINFORCED CONCRETE PONTOON

A reinforced concrete pontoon has been constructed to the order of the Sydney Harbor Trust by Stone and Siddeley, of Sydney, Melbourne, and Geelong. The pontoon is to be placed in position at the eastern end of Circular Quay for the use of the Lavender bay and Parramatta river ferry services.

The dimensions of the pontoon are: 100 ft. in length, 53 ft. 3 in. wide at one end, and 67 ft. 7 in. at the other, depth, 7 ft. 9 in., with a 32-in. freeboard. The bottom is flat and the sides and ends are sloped to an angle of 70°. Special attention has been given to the design of the steel work with a view to enable the construction to withstand the excessive strains likely to occur should vessels be berthing at each side of the pontoon at the same moment. In the construction of the top and bottom of the pontoon allowance has been made for a live load of 150 tons, which will be distributed between the posts.—*Commonwealth Engineer.*

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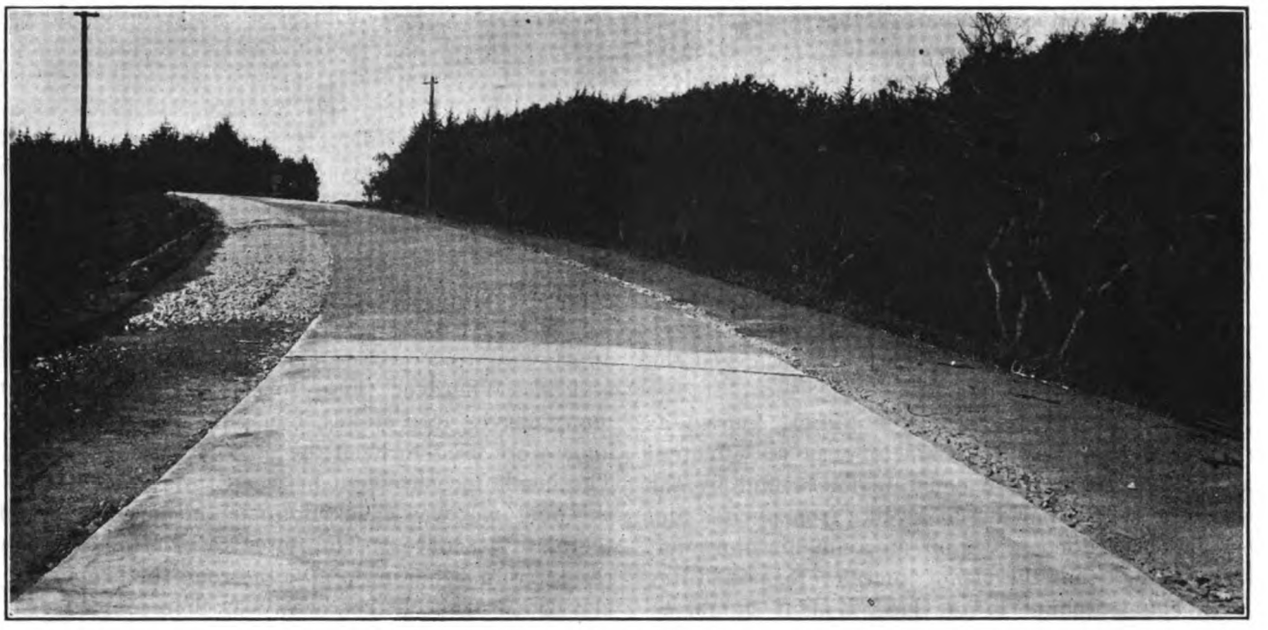

Concrete Road at San Francisco Presidio*

The U. S. War Department has authorized and partially completed the construction of a one-course concrete roadway, 12 ft. wide and more than three miles long at the Presidio and Fort Winfield Scott, in San Francisco, California. This modern roadway connects with a waterbound macadam and red rock roadway, now obsolete because of its badly rutted surface and the fact that it was not laid to a satisfactory grade. The War Department after careful consideration of various types of pavement chose this type of road as capable of withstanding the severe requirements of heavy teaming at the military post, as well as the automobile traffic which will be a considerable factor in road wear during the Fair in 1915. The road extends from the First avenue gate and terminates at the cross-roads near the U. S. Naval cemetery.

The road winds along the high ridge overlooking the Golden Gate. The maximum grade does not exceed 5% and no particular effort was made to have level stretches which would necessitate much excavation. After the experience with the other type of road and its high maintenance expense, an effort was made to secure this permanent improvement with a rather limited appropriation. For this reason, on either side of the concrete roadway are 4-in. macadam shoulders covered with screenings and varying from 6½ to 11½ ft. in width. This makes the new road vary from 25 ft. wide to a maximum width of 35 feet.

Foundation

Very little excavation was made for the foundation of the new road, so that the settled water-bound red rock road was used as far as possible for the subgrade. Few drains were required because the road is along a well drained ridge. Where drainage was required, loose rock was placed in trenches about a foot wide and deep, and well rolled before concrete was placed.

Materials

The facilities, equipment, and men at the disposal of the Government were used where possible. Sand was obtained from the beach close to the old Fort Point fortification on the San Francisco side of the Golden Gate. This sand proved especially suitable because it was well graded and sharp. It was screened to remove tule grass and lay exposed at the shore along the line of work until it was thoroughly dried so that salt which may have been present would have no action upon the concrete. The Government quarry, at Angel island, furnished the rock, which was transported in barges to the wharf at Fort Winfield Scott, where it was placed in bunkers. Motor trucks then conveyed it from storage to the desired points on the new road. It was originally intended that this material be placed in piles 100 ft. apart so that the concreting might be carried on by the horse-cart method of distribution from a side discharge concrete mixer, but in practice the material was strung out along the line so that maximum efficiency was obtained when a traction rear discharge concrete mixer was employed. All the cement used was made by a local cement company, and delivered in cars to the Government spur, thence conveyed by the above mentioned auto trucks in 120-sack loads to the work. These were unloaded close to the mixer, but where the delivery was faster than the consumption, cement was stored in tents not over 400 ft. apart. These tents are shown in accompanying photographs. Water

*Staff article.

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supply was one of the problems of the work and was obtained from the Presidio reservation and carried in a 2-in. pipe along the side of the roadway with unions and plugs about 100 ft. apart. From this supply the water for wetting the subgrade, for concreting, and curing the finished roadway, was obtained. The subgrade was wet well either the night before or considerably in advance of the mixer, to the end that the ground might be moist, but not muddy, which would impede the mix or give possibility of the men tracking dirt into the concrete materials or the concrete. The exclusion of dirt and foreign matter was considered the biggest problem of the work.

The use of a metal powder or filings, known as 'metalcrete', has proved satisfactory as an effectual preventive of abrasion in concrete floors laid by the Government. This powder looks like iron pyrites and when water is added, gives off an ammonia-like odor. It was specified that the use of 'metalcrete' mixed dry with an equal amount of portland cement should be placed on either side of the metal expansion plates, which were ½ in. wide and extended through the concrete. This 'metalcrete' was used to strengthen the weakest part of the concrete road and is considered superior to the metal expansion joint used in the Wayne county, Michigan, work. It might be mentioned that the specifications used by this county had a considerable influence in determining the methods employed, although different equipment and organization were used.

EXPANSION PLATE. RODDERS AND FLOATERS CLOSELY FOLLOWING MIXER.

TEMPLATE FOR CROWNING AND METHOD OF FINISHING IS CLEARLY SHOWN.

Mixture

All concrete was of one part portland cement, two parts sand, and three and one-half parts crushed rock. The accuracy of this mixture was determined by measuring with a box holding exactly one sack of cement. This was checked up frequently and especially when new men were taken on the job. The actual mixing and placing of the materials was performed by contract, all other work being done by the Government.

Construction

About 2000 ft. of water-pipe was laid before work began, and before the aggregates were delivered the roadway was staked off in 100-ft. units so that the exact yardage of rock and sand plus 10% for waste might be strung along the work. The excess of sand worked out as a little more than 10% because some was used in making a 1-in. coating on the finished concrete, over which water was sprinkled properly to cure the concrete. A 10-ton steam-roller, pulling a Rotter road plow, was sent over the roadway which had been previously staked off, 13 ft. wide. The work of the roller was confined to tearing up a trench on each side, which was then excavated and wooden forms, 2 by 6 in. by 16 ft. laid to a proper grade were held in place by stakes. Wherever these forms were placed on the many curves, iron stakes, 1 in. square and about 30 in. long, were used to keep the 2 by 6-in. boards in place. The inside measurement between forms was 12 ft. and this distance was checked up by means of a wooden template at curves. The outer rail of the forms was raised from 3 to 6 in. to give the road the proper superelevation. The old roadway was then plowed up and all material shoveled to the side of the road, opposite the crushed rock and sand. After the roadway had been dressed to a proper grade and sprinkled, it was rolled to uniform compactness by a 10-ton steam-roller. The Government crew endeavored to keep at least 500 ft. in advance of the mixing plant, as this was the average capacity of the contractor's equipment.

Organization

A civil service crew for the Government was under the supervision of a superintendent with the following assistants (also monthly employees): one roadman, one engineer on the steam-roller, and two carpenters for laying forms, and 25 laborers, who constituted the average crew. Considerable difficulty was experienced in the hiring and discharging of these men, because they were all obliged to conform to the routine of civil service application, examination, etc.

Mixing

The work was not begun at one end and carried to completion, but, because of peculiar traffic regulations, was started in the centre, carried toward the National

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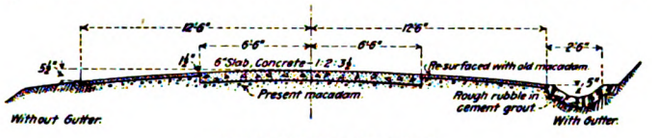
CEMENT PILED HANDY FOR LOADING.

cemetery, and then work was begun at the First avenue entrance. On the first section, the mixing equipment developed difficulties due chiefly to the gasoline engine troubles, which retarded the rapid progression of the work. On the second section, a Foote 6 A concrete paving mixer did the work. It will be seen in the accompanying photograph that this machine enabled the laborers to charge the hopper quickly, which was under the control of the engineer on the mixer. The segmental discharge chute enabled the placing of the concrete quickly and economically. The specifications required that aggregates be given twelve complete revolutions, water to be added on the fourth revolution, but the excellent mix possible in the equipment made this requirement unnecessary. The concrete was struck off



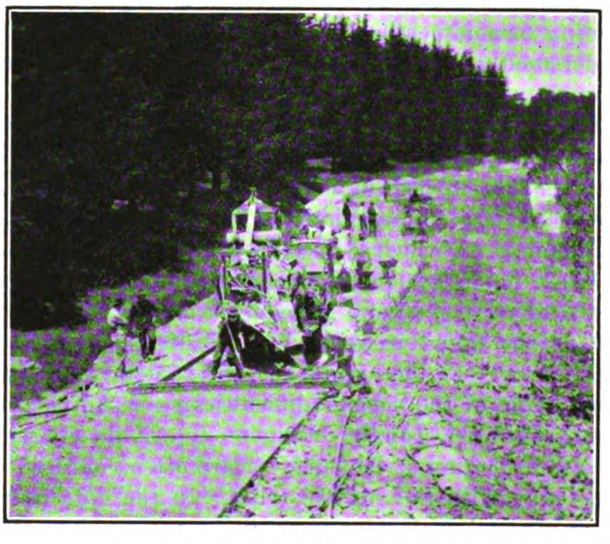
CROSS-SECTION OF ROAD.

to proper grade, and crowned by means of a heavy wooden template with iron shoes, which two laborers worked along the side rails. The template and method of finishing is clearly shown in the photograph, and gave the roadway 1½-in. crown. Two men with floats immediately followed the template and endeavored to depress any crushed rock which might show on the surface, and to cover the same with a thin layer of cement mortar. The purpose was to have the concrete surface slightly roughened. The sides of the road and expansion joints were slightly rounded. At this point, strict orders prohibiting walking, throwing or laying anything on the soft concrete were rigidly enforced. The usual signs and barriers to pedestrians were placed at many places along the road. At the end of each 50-ft. run, or at the end of the day's work, the expansion joints were made by means of the ½-in. wide metal expansion plate, shown in photograph. This was 6 in. thick, shaped to give the 1½-in. crown, and had handles on each end. It was well soaped before using so that it might be easily withdrawn from the concrete. As was stated, the 'metalcrete' and portland cement mixture was placed at either side of this plate to strengthen the expansion point. The plate was removed as soon as the concrete had taken initial set and over the opening a board was nailed so that leaves, dirt, etc., would not enter the joint prior to the pouring of hot asphaltum. After the concrete roadway had taken its initial set, the work of the day was covered with burlap, which proved more economical than canvas, although not as effectual in wet weather. This point, however, is a minor one, because good weather was assured at the season the work was carried on. The burlap answered extremely well and in one case saved concrete only six hours old from damage by rainfall. The succeeding day the burlap was removed and the same kind of sand as used for the mixture was applied to a depth of about an inch and kept wet at least eight days. Much attention was given at this point, and the concrete developed an even and gradual set. Especial care was paid to all phases of the work around the expansion joints, both in keeping the expansion plate from bulging when the concrete was placed behind it, and to see that the height of the concrete on both sides of the plate was the same. In starting work, the edge of the concrete next to the expansion joint, at the beginning of the day's run, was left slightly higher, so that the normal contraction of the concrete would bring the height of the finished roadway to conform to the set of the hardened concrete of the day before.

The work was carried on in such a way that it is difficult to furnish cost figures which would be of value to engineers or contractors. The Department estimated a cost of $2.24 per running foot for the concrete roadway as above made, and this estimate proved approximately correct.

The contractor's crew consisted of: one superintendent, one engineer, one cement loader, two floaters, two men on templates, three sand wheelers, six rock wheelers, and two cement wheelers.

The work was under the supervision of Col. Geo. McK. Williamson, represented on the work by Capt. A. R. Kerwin. The contractors were Gass Bros., of San Francisco.



TYPICAL CONSTRUCTION ARRANGEMENT.

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Use of Graphic Models in Showing the Geology of Oil and Gas Pools

By L. G. HUNTLEY*

The use of graphic models has largely been restricted to showing topographic features and in connection with mining problems, although their use in the class room has been demonstrated in engineering schools.

In the first case, they are used in connection with problems which arise in the construction of large drainage systems, canal and water power projects, and various municipal undertakings. In the second case they are used in two entirely different ways: (1) To aid in the development work of mines. For this purpose both transparent skeleton, and opaque block models are used, generally so constructed that they may be altered and added to as underground development proceeds.

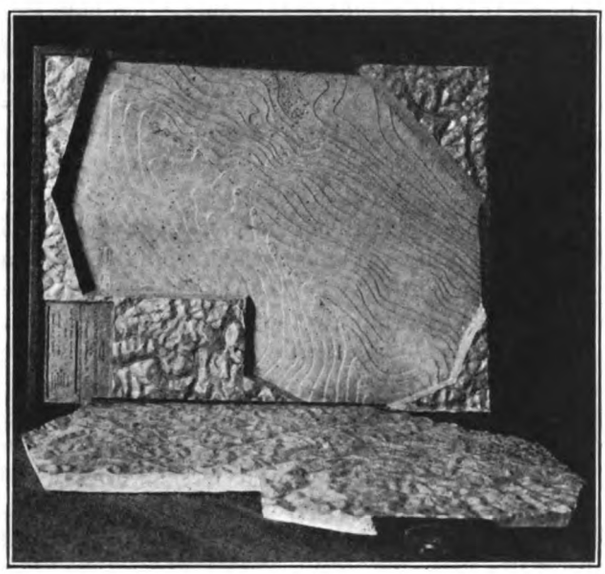

FIG. 1.

(2) Models are used also to excellent advantage in presenting to non-technical judges and juries in an easily understood manner some of the many points which annually grow out of our present apex mining law.

The class room has also taken similar advantage of all forms of models which have been used in practical work. The expense of obtaining satisfactory models for the class room has hindered its more extensive use in this field, to which it is so adapted.

While doing geological mapping in connection with work for various oil and gas companies in recent years, the author found it especially difficult to explain to many operators the significance of structure contour lines. One of the various difficulties seems to be that these contours (usually drawn on top of an oil sand or key formation at the surface) are often confused in some way with the surface relief. In the old eroded areas of the Appalachian basin this confusion is particularly unfortunate, as in most cases the surface topography has not the slightest relation to the underlying structure of the oil sand.

In the effort to show this satisfactorily the author constructed several models, one of them with transparent sides, to show the 'lay' of the sedimentary formations in portions of the Ohio oilfields. This was found unsatisfactory, the model being too cumbersome and complicated, while the time consumed in its construction was an important factor. Resource was then had to the work of a well known professional map maker, who constructed a plaster model according to specifications furnished to him; with results that combined simplicity with a very clear presentation of facts. Fig. 1 is a photograph of such a model, showing the 'lay' of the Hundred-Foot sand in the Fairmont district in West Virginia. This cut shows the upper topographic section removed; while Fig. 2 shows this in place; and also shows to the right a relief map of the Frazeysburg Quadrangle in Ohio, this latter being the surface section of a model constructed by the author. The topographic relief in both cases is based on U. S. Geological Survey quadrangle maps.

In Fig. 1 it will be seen that each contour drawn upon the top of the oil sand is indicated by a 'terrace'. That is to say, the slope is not graduated between contours, giving a somewhat unnatural appearance. It has been found that a better method is to show an even natural slope to the sand, the contour lines being merely drawn at intervals corresponding to 20-ft. or 50-ft. changes in elevation as the case may be.

Another application of the use of such a model to represent underground conditions in relatively horizontal stratified rocks, was in the case of a large hydro-electric project in one of the streams of the western Appalachian ranges. The coal underlying the basin in question had been acquired some years before by two large companies on the evidence of a somewhat superficial examination. Later developments showed that

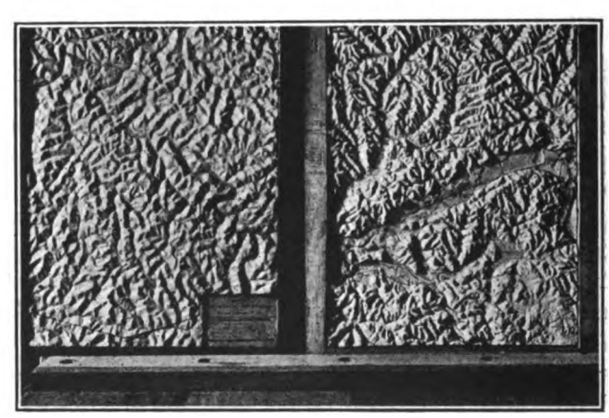

FIG. 2.

*Geological Engineer, 331 Fourth Ave., Pittsburgh, Pa.

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most of the coal was unworkable commercially, and when the hydro-electric company commenced operations it seemed a good time to 'unload' at high prices. After a careful geological survey of the flooded basin by the power company, in the preparation of evidence for possible litigation it was found that a graphic plaster model, with sections lifting off at the horizons of the principal coal seams, showing the flooded areas and thicknesses of the coal at various points, was an almost ideal way of presenting the conditions for a courtroom exhibit. The superimposed sections were held in place by dowel pins. The water in the proposed storage reservoir was shown by means of transparent gelatin of suitable color, and the areas of a coal bed lying below the projection of this plane were shown graphically directly on the surface representing this coal, after the top surface section had been removed.

The possibilities of the use of graphic models of this nature are apparent, as they simplify the engineer's work of presenting his report either to a jury or to his clients, who as a rule are unfamiliar with the significance of the symbols used in geological mapping.

Permanent Road Construction

In answer to an inquiry for information on road construction, Highway Engineer A. B. Fletcher recently made the following reply to a California correspondent, as published in the *California Highway Bulletin* for July:

At the outset I have to confess that I know of no type of pavement which can truly be called 'permanent,' and the expression must be considered as only relative. I know of no pavement or roadway which does not require, from the day it is constructed, more or less expenditure for maintenance. If no other work is needed for the first few years, the roadsides, gutters, and culverts have to be looked after.

As concerns the pavement proper, I believe of the types within the means of the more opulent states and counties at the present time, that most nearly approaching the ideal consists of a concrete base of thickness sufficient to properly sustain the traffic which it must carry with a wearing surface of asphaltic concrete from 1½ to 2 in. thick.

Such a pavement 20 ft. in width and with the base only 4 in. thick would probably cost, under the conditions in your county, not less than $14,500 per mile for the paved portion of the road, assuming that the concrete can be laid for $6.25 per cubic yard and the asphaltic concrete surface for 6c. per square foot. To this must be added the cost of grading, culverts, drains, and any special treatment of the shoulders or beams on the sides of the pavements.

Few of the states, and hardly any of the counties with which I am familiar can afford so great an expenditure per mile.

In the instance mentioned, a thickness of concrete base of 4 in. was assumed. In my opinion, so thin a base should be adopted only when the subgrade is of excellent quality both as concerns the material composing it and the rolling done upon it to make it compact and unyielding, and when the inspection of the construction is adequate. Eternal vigilance is necessary to prevent construction of the base thinner than the specifications provide for.

If the base be increased in thickness to, say, 5 in., one-fourth must be added to its cost, or about $2000 per mile, making a total probable cost of $16,500 per mile.

It was early apparent to the Commission in its State Highway work that no such road as has been discussed above was possible if justice was to be done to all parts of the state. The main routes, requiring paving aggregating about 1300 miles in length (less than one-half of the total mileage called for by the State Highways Act), if built as above described, but with the paving only 15 ft. wide, would cost, grading and culverts included, more than $16,000,000, and, adding the overhead expense, there would be almost nothing left for the other half of the system.

This consideration led the Commission to seek a type of road cheaper in first cost, notwithstanding a consequential higher maintenance expenditure during the early years of its existence, and the type called 'concrete base with bituminous top' was adopted rather generally.

In this method of construction the base is the same as if the 1½ to 2-in. covering were to be applied, but instead a thin coating of asphaltic oil of special quality is put on to the concrete by spraying machines at the rate of about ½ gal. to the square yard. Clean stone screenings or coarse sand are then added in sufficient quantity to absorb the oil. The process requires much care in the selection of the materials used and in their manipulation, but the result is a bituminized coating about ⅜ in. thick. The cost of such surface work ranges from 5 to 10c. per square yard, or $600 to $1200 per mile, roughly, for a 20-ft. pavement, depending on the cost of materials and local conditions. This means that more than 90% of the cost of the work on the road goes into grading, culvert work, and the concrete base, all of which may be considered as practically permanent, and the remainder into the thin wearing surface.

Such a wearing surface should last from two to four years before it requires renewal, which renewal should cost considerably less than the original application. The thin surface is best adopted to rubber-tired vehicles, but it wears well with mixed traffic consisting of both rubber and iron-tired vehicles.

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I would have no hesitancy in recommending the thin road surface for a road covering for as many as from five to six hundred vehicles per day, provided a considerable portion of the vehicles is rubber tired.

If the concrete is covered with a 1½ to 2-in. coating of asphaltic concrete, under ordinary conditions there will be but little cost for maintenance except on the roadsides and for cleaning culverts for the first five years, but after that period the surface will require attention from time to time in patching and applying seal coats, and when the road needs a new surface it will doubtless be found that the maintenance cost has been in excess of 2½c. per square yard per year.

Another type of road which the Commission has constructed to the extent of nearly 20 miles is the so-called 'oil macadam' road. When properly built, I consider this type of work worthy of adoption in many cases, but it has been found, in this state at least, that it is very difficult to secure uniformly good results. There are many contributing causes to the failures or part failures, and the Commission has favored the cement concrete type because of the greater certainty of result and because also the concrete so far has cost about the same as 'oil macadam.'

My experience in the East leads me to believe that the 'oil macadam' pavement costs for maintenance not much less per mile per year than the cement concrete base with thin asphaltic top, and this is borne out in the case of the San Joaquin county work here in California. Los Angeles county has constructed many miles of this sort of road, and the costs of maintenance there should be easily obtainable.

Much work is being done in the cities and to some extent in the country of the type known as 'asphaltic concrete.' This pavement in its original form was patented and is often called 'bitulithic.' With a hard unyielding base, a thickness of 4 in. may be used with good results, but unless the subgrade is nearly perfect, the upper surface of the road is likely to become wavy under the traffic. This sort of pavement costs from 12 to 16c. per square foot, $12,500 to $17,000 per mile, 20 ft. wide, for the pavement alone. About 20 miles of such pavement was put down several years ago in San Joaquin county, of an average width of 11 ft. I am told that, including the grading, this work cost about $11,000 per mile.

In Alameda county, in the vicinity of Dublin, at the present time, a road of this general type is being built at a cost of about $30,000 per mile, including the grading, the pavement being, if my information is correct, 30 ft. in width.

My personal preference is for a concrete base with an asphaltic concrete top from 1½ to 2 in. thick, rather than for the full thickness of asphaltic concrete.

I am sorry that this letter is so long, but explanations seemed necessary. To answer your questions categorically is nearly impossible, but in my judgment a 'first-class all-the-year-round highway' can be constructed to stand the mixed traffic of our county highways and continue of durable character at a reasonable cost for upkeep, but I question if the cost can be kept below $300 per mile per annum on a 20-ft. roadway.

Such a road as before discussed, with a concrete base 4 in. thick and 20 ft. wide, covered with the thin coat of asphaltic oil and screenings, will probably cost under your conditions not less than $9000 per mile for the pavement alone.

EFFECT OF CONCRETE ON STEEL

That concrete has a preservative effect on steel has long been known, and many instances have occurred where ancient concrete has been broken away from metal with which it had been in contact for ages, and it has been found that the surface of the metal was as bright and clean as on the day when it was first placed in position. Some remarks made by Dr. W. H. Walker (the Director of the Research Laboratory of Applied Chemistry of the Massachusetts Institute of Technology) some little time ago will well bear repeating in this connection. Every engineer is well aware of the fact that acidulated water, no matter how small the percentage of acid may be, tends to corrode steel by increasing the number of hydrogen ions present, and Dr. Walker made it clear from the tests he carried out that there were certain alkaline substances present in concrete which corrected any acidity, and so protected the contained metal work from corrosion.

This fact has an important bearing upon the question, which lately has been much discussed, as to whether concrete will protect iron or steel from corrosion. Inasmuch as portland cement, when it sets or hardens, liberates a quantity of caustic lime, which is a strong alkali, and since good concrete is saturated with this strong alkali, the answer to the question must be in the affirmative. Iron or steel will not corrode when embedded in concrete. But caustic lime is soluble in water, and poorly made concrete is not impervious to moisture. Therefore, if iron be embedded in concrete through which water is allowed at any time to percolate, this calcium hydrate will be slowly, but surely, dissolved. With it will disappear the inhibiting action of the concrete and iron embedded therein will, in time, rust and become corroded. To ensure absolute protection of the reinforcing members of concrete construction, therefore, such concrete must be of good quality, and sufficiently dense and carefully made to render it waterproof.—*Canadian Engineer.*

A cement for making repairs on switchboards when iron or other metal has to be fastened to marble may be made from 30 parts plaster of paris, 10 parts iron filings, and ½ part of sal-ammoniac. These are mixed with acetic acid to form a thin paste. This cement must always be used immediately after being mixed, as it solidifies if allowed to stand for any length of time.

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Inertia Effects in Pipe-Lines

By S. L. BERRY*

An extended and detailed study of the conditions to be found in pipes conveying water, when the velocity of flow is changed, has led to the conclusion that there has not been an adequate recognition of the importance of considering the elasticity of both the water and the pipe walls. It has become clear that only by such consideration can correct results be obtained.

It is commonly admitted that the rapidly moving pressure waves set up, when a valve is opened or closed, are annoying and, when excessive, must be taken care of by relief valves, but it is claimed that they have no place in those greater and longer movements which accompany velocity changes. A formula which is often used to calculate these effects ignores the compressibility of the water and the elasticity of the pipe material. It is the purpose of this article to show clearly that this formula is absolutely and unequivocally wrong, has no foundation in fact, and must lead to erroneous results.

At the foundation of all these phenomena is gravity, the manifestation of nature which gives to bodies that quality called weight, which when opposed produces pressure and when unopposed produces movement. Should the opposition decrease, the pressure will decrease and the velocity increase, and vice versa. This is universal and applies to all ponderable bodies. Such influences as friction, which cause a loss of energy, will modify the results in accordance with their magnitude.

Inertia is that quality of bodies which tends to keep them in a given state of rest or motion unless acted on by some force. A body in motion has energy in proportion to its weight and to the square of its velocity. It is evident, therefore, that to increase the velocity of a body it is necessary to put energy into it, and to decrease it, energy must be taken from it. This act is called overcoming the inertia of a body. It is furthermore true that with a given change of velocity, the amount of energy put in when accelerating will be the same as that taken out when retarding. In other words, acceleration and retardation differ only in direction, the energy change being the same with any given velocity change.

The above remarks are elementary in nature and are introduced solely for the purpose of laying a foundation for what follows.

Consider a pipe-line filled with water under pressure and provided with a valve at the lower end. When the valve is in a closed position the water is compressed and the pipe distended in proportion to the pressure. In this case gravity, being opposed, produces pressure. On opening the valve the opposition to gravity decreases and movement results. This commences at once, and the velocity at a point behind the valve will be in proportion to the fall in pressure at that point. Whether a gauge located there will correctly indicate the fall in pressure will depend upon its accuracy and sensitiveness and upon the manner in which it is attached to the pipe. In this case the energy which must be put into the water to increase its velocity comes from the water itself and from the pipe walls, which are now under less stress, and which have given up a portion of the energy stored in them. This involves a change from potential to kinetic energy.

On the other hand when the valve is moved in a closing direction, the opposition to gravity is increased, the velocity decreases and the pressure increases; the energy given up by the water as a moving body is stored in the water and pipe walls, the one being compressed and the other distended.

In both instances an unstable condition is set up, as in the first case the pressure is much below that due to the head, and in the latter much higher. The former persists until the energy taken can be restored, which occurs on the return of the wave from the reservoir, and the latter until the excess stored can be dissipated. Equal velocity changes are accompanied by equal pressure changes whether the water be accelerated or retarded.

The changes which commence at the valve are followed by changes along the pipe-line, pressure waves traversing the pipe at velocities dependent upon the material of the pipe walls and the ratio of wall thickness to diameter.

In a previous article† formulae and diagrams were given to determine the velocity of wave propagation and the maximum ram pressure attained under any given set of conditions, and reference is made thereto for these particulars.

It is to be noted that if, in a given case, a decrease in velocity of flow of 1 ft. per second is accompanied by a ram pressure of 50 lb., a like increase in velocity will be accompanied by a fall in pressure of 50 pounds.

The formula commonly used for calculating the inertia effects of velocity changes is

$$Ha = \frac{L\ v}{g\ t}$$ in which,

Ha = accelerating or retarding head in feet.
L = length of pipe in feet.
v = velocity change, feet per second.
t = time of change, in seconds.
g = 32.2 feet per second.

This considers that the pipe is rigid and the water incompressible. It necessarily includes, as a condition, that, in a uniform pipe, all the water shall have the same velocity at the same time; that any change in velocity at the lower end shall be accompanied simultan-

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†'Water Hammer', *Western Engineering*, Dec. 1912.

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eously by the same changes throughout. This is indicated by the inclusion of L, the length of the pipe. As a matter of fact such a condition has been shown, theoretically and experimentally, to be impossible.

The most extensive and thorough experiments along these lines were made in 1897 and 1898, in Moscow, Russia, by three engineers, working under the directions of N. Simin, manager of the city water works. The results were worked up by N. Joukowsky, in 1898 and published in 1900.

These show conclusively that changes initiated at the valve produce changes along the pipe after a time interval dependent upon the distance and the velocity of wave propagation, and they prove, in a very satisfactory manner, the formulae which have been developed by theoretical means.

To bring out clearly the difference in results between the correct elastic theory and the incorrect rigid formula, the following table has been prepared. It applies to a steel pipe, 24 in. diameter, ¼-in. wall, and having lengths as listed. The velocity of wave propogation is 3370 ft. per second.

Pipe=1000 ft. long.							
Time of gate closing, sec....	0.00	0.02	0.04	0.10	0.30	0.45	0.60
Pressure, rigid formula.....	00	675	337	135	45	30	22
Pounds, elastic formula.....	45	45	45	45	45	45	45
Pipe=10,000 feet long.							
Time of gate closing, seconds	0.00	0.02	0.10	0.30	1.00	3.00	4.00	5.00	6.00
Pressure, rigid formula	00	6750	1350	450	135	45	34	27	22
Lb., elastic formula	45	45	45	45	45	45	45	45	45

There are several interesting facts brought out in the table. In the rigid formula the pipe length has a decided influence on the calculated result, while in the elastic, it has none whatever as far as the amount of pressure is concerned, but it does control the duration of this pressure. This has been amply proved by experiment. In the rigid formula the time of gate movement has an inverse proportionate effect upon the calculated pressure, while in the elastic, within certain limits, it has no effect. There is this fact to be noted in this connection, that the rigid formula requires that the pressure shall instantly rise to the figure given and remain there during the entire closing movement of the gate, and that the elastic indicates that the rise will be gradual and in proportion to the decrease of velocity. Experiments have shown that the former is not true and that the latter is true.

The pressures agree for a closing time equal to the time required for the wave to reach the reservoir, but with the non-elastic formula, this pressure must be considered to have existed during the entire time, while in the elastic, the maximum is reached only at the end of the period. To obtain this pressure throughout the entire period, using the elastic formulae, the gate would have to be closed instantly. With less closing time than that mentioned above the non-elastic formula gives results which are excessive, and with greater results which are too low.

There is nothing in the non-elastic formula to account for that lagging effect which is so well known and which causes recurring waves. These are perfectly accounted for by the elastic theory, and, under proper conditions, can be predetermined.

At the limits given in the table the pressures given by the elastic formulae commence to fall off, decreasing with increase of closing time. It is readily seen that with long conduits a great variance in results will be found, and as the elastic formulae are based on actual conditions fixed by natural laws, a choice should not be difficult to make.

The table is based on a velocity of only 1 ft. per second. For changes of 5 to 10 ft. per second the differences would be much increased, as the ram pressures in both cases increase in proportion to the velocity change.

It is evident that the non-elastic formula is based on certain assumptions, namely, that water is incompressible and that the pipe walls are rigid, which are not true; therefore the results obtained by its use cannot be correct. How great the variation will be will depend, as shown in the table, upon the time taken for the velocity change.

On Shoshone river in Wyoming, a tributary of the Bighorn, which in turn is tributary to the Yellowstone, which joins the Missouri in eastern Montana, is located the Shoshone dam, the highest structure of its kind in the world, 328 ft. from foundation to capstone. This structure was erected by the Government to impound water for irrigation on the arid lands in the valley of Shoshone river below. Another great structure of a similar kind is located in Wyoming, on North Platte river, which joins the Missouri near Omaha, Nebraska. This is known as the Pathfinder dam, and was also erected by the Government to impound water for use in the irrigation of lands in Wyoming and Nebraska. Another notable engineering structure in the drainage basin of the Missouri river is the Belle Fourche dam, erected across the river of the same name in South Dakota by the Government to impound water for irrigation. This dam is an earth embankment 155 ft. high and 1⅛ miles long, containing 1,600,000 cu. yd. of earth fill. This is the largest earth dam in existence. Copies of Water-Supply Paper 306 may be procured upon application to the Director of the Geological Survey, Washington, D. C.

In oiling machinery, particularly bearings, always make it a rule to see that it is done ten or fifteen minutes before quitting time. The bearings are then warm and will easily take oil and be ready to start promptly the following morning. It doesn't take any more time to oil the machines this way, and the possibility of hot-boxes is considerably less. Bearings that are oiled in the morning when they are cold are much more likely to run hot than bearings oiled the night before when they are warm.

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Portland Cement Concrete Bases for Roads*

By J. B. WOODSON†

The 4-in. base of portland cement concrete, consisting of a proper mixture of 1, 2½, and 5, if constructed upon a perfectly prepared subgrade, should afford sufficient strength to carry all traffic and any type of road vehicle now existing. Except in alkali, quicksand, or marsh-land soil, the 4-in. thickness is as good as a foot, so far as sustaining qualities are concerned. Through unstable soil sections the pavement should be increased in thickness according to the degree of firmness of subgrade. Some soils make a firm subgrade, but warrant extra thickness of pavement.

For example, adobe makes the hardest kind of subgrade if the clods are pulverized, but 'wet streaks' in an adobe fill would, upon evaporation, have a tendency to settle locally; this in effect would require greater spanning power, which virtually means a heavier beam.

Under the heading of adobe should be classified alkali and dry bog. This latter, when thoroughly dry, resembles volcanic ash, and the difference in its displacement under dry compression and when it is wet and heavy would produce an appreciable stress up under the pavement. All forms of adobe, however, have the cracking qualities in the dry season, and it is doubtful whether the extra thickness of concrete would prevent the cracks breaking through the pavement above.

Pavement construction on a low grade-line, over marsh-land or wet sandy soil, should be augmented by increased thickness of concrete.

Concrete for 4-in. pavement should be mushy but not 'sloppy.' It should be dry enough to require considerable tamping before it looks wet on top.

When the mixture flows out on the chute as if under pressure resembling a fire hydrant, the work should be stopped until the water feed can be adjusted. Some contractors claim that with a certain type of mixer the concrete will not discharge down the chute unless the mixture is very wet. This is a mistake, and when the water runs down the pavement in little rivulets floating away from the mortar, it won't be long under traffic until the rocks begin to break loose. The concrete should be tamped until the individual rocks disappear in the mortar, and the final floating should leave the pavement smooth and true to section. The floating is done with a wooden float, and from 20 to 50 ft. in the rear of the placing of concrete. Some men soon become skilled in making a good finish.

A ten-ton roller is used in preparing the subgrade to shape. Sufficient rolling is done to compact the rough-grade firmly. The rough-grade is left from ½ to 1 in. high for compression. When finished, the subgrade is theoretically parallel and 4 in. lower than the desired elevation of pavement. The section drops ⅜ in. per lineal foot each side of the crown, the bottom header board being 2¾ in. lower than the crown.

When the concrete is sufficiently set, which in time varies according to the weather from six to twelve hours, 2 to 4 in. of loose dirt is thrown over the pavement and is kept wet for a period of six days, and on later contracts ten days. During the hot weather, great care should be exercised in seeing that the concrete is moist under the covering of earth. A more satisfactory method of curing the concrete is by building little dikes about 20 ft. apart and along the edge of the pavement, and flooding the concrete twice a day, or oftener if needed. This latter method always shows if the concrete is wet, is cheaper for the contractor, and is much more easily cleaned off.

Cleaning off the pavement is usually done with a road grader, the dirt being thrown out on the shoulders, again shaped, and rolled.

An approximate cost, as shown by our records, of covering with dirt is 2.5c. per lineal foot, or 13.4c. per cubic yard of concrete. The cost of diking with dirt is 1.25c. per lineal foot, or 6.75c. per cubic yard of concrete.

When all the dirt is taken off that can be removed with the road grader, horse brooms are run over the pavement. If the dirt still remains in patches, shovels and stable brooms are applied.

The natural transverse cracks appear about 28 ft. apart. This varies considerably, according to the materials used and the care in keeping the concrete wet. With all forms of cracking that have developed so far, no serious trouble is noticeable in wearing of concrete or appearances, and the bituminous wearing surface enters the crevices and covers them until they are scarcely perceptible.

Artificial construction joints do not seem to warrant the expense attached to them in the construction of concrete pavements in California. Where they have been used by means of redwood strips placed between strips of tar paper, the joint wears away under traffic and the regular crack appears at its natural interval. The cost of steel expansion joints is practically prohibitive for the benefit derived, and they do not eliminate the cracks. Steel reinforcing is not desirable for pavements, owing to the expense. It would seem more practical to increase the thickness of pavement over sections of doubtful subgrade.

Out of five days' run on a contract near Fresno, at an average of 762 lineal feet of 15-ft. pavement, the following force was used:

Foreman, 5 days at $4	$20.00
Labor, 5 days at $3.50	17.50

*Abstract from *California Highway Bulletin*, July 1914.

†Division Engineer, California Highway Commission.

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Labor, 6 days at $2.50	15.00
Labor, 132½ days at $2	265.00
Wagon and driver, 5 days at $4.50	22.50
Concrete mixer, fuel, etc., 5 days at $5	25.00
Water pump and engineer, 5 days at $6	30.00
Total	$395.00

Total length of run, 3808 lineal feet, or 705 cu. yd. of concrete; 56c. per cubic yard. On a cubic yard basis the cement cost $2.17, the stone cost 71c., and the sand cost 43c. The average cost of unloading and transportation of material was 68c. The total cost per cubic yard of concrete in place was $4.55.

COSTS OF CONCRETE BASES, 15 FEET WIDE, AT VARIOUS PRICES PER CUBIC YARD

	Depth, in.	Cu. yd. per mile.	Cost per mile.	Cost per sq. ft.	Cost per sq. yd.
$5.00 per cu. yd.	4	978	$4890	$0.062	$0.556
	4½	1100	5500	0.069	0.625
	5	1222	6110	0.077	0.694
	5½	1344	6720	0.085	0.764
	6	1467	7333	0.093	0.833
$5.25 per cu. yd.	4	978	5135	0.065	0.584
	4½	1100	5775	0.073	0.656
	5	1222	6416	0.081	0.729
	5½	1344	7056	0.089	0.802
	6	1467	7700	0.097	0.875
$5.50 per cu. yd.	4	978	5379	0.068	0.611
	4½	1100	6050	0.076	0.687
	5	1222	6721	0.085	0.764
	5½	1344	7392	0.093	0.840
	6	1467	8066	0.102	0.917
$5.75 per cu. yd.	4	978	5624	0.071	0.639
	4½	1100	6325	0.080	0.719
	5	1222	7027	0.089	0.799
	5½	1344	7728	0.098	0.878
	6	1467	8433	0.106	0.958
$6.00 per cu. yd.	4	978	5868	0.074	0.667
	4½	1100	6600	0.083	0.750
	5	1222	7332	0.093	0.833
	5½	1344	8064	0.102	0.916
	6	1467	8800	0.111	1.000
$6.25 per cu. yd.	4	978	6113	0.077	0.695
	4½	1100	6875	0.087	0.781
	5	1222	7637	0.096	0.868
	5½	1344	8400	0.106	0.955
	6	1467	9166	0.115	1.042
$6.50 per cu. yd	4	978	6357	0.080	0.722
	4½	1100	7150	0.090	0.812
	5	1222	7943	0.100	0.903
	5½	1344	8736	0.110	0.993
	6	1467	9533	0.120	1.083

COSTS OF 15-FOOT PAVEMENTS

(79,200 sq. ft. to mile. 8800 sq. yd. to mile.)

Per sq. ft.	Per sq. yd.	Per mile.	Per sq. ft.	Per sq. yd.	Per mile.
$0.001	$0.009	$ 79.20	$0.115	$1.035	$9,108.00
0.002	0.018	158.40	0.120	1.080	9,504.00
0.003	0.027	237.60	0.125	1.125	9,900.00
0.004	0.036	316.80	0.130	1.170	10,296.00
0.005	0.045	396.00	0.135	1.215	10,692.00
0.006	0.054	475.20	0.140	1.260	11,088.00
0.007	0.063	554.40	0.145	1.305	11,484.00
0.008	0.072	633.60	0.150	1.350	11,880.00
0.009	0.081	712.80	0.155	1.395	12,276.00
0.010	0.090	792.00	0.160	1.440	12,672.00
0.020	0.180	1584.00	0.165	1.485	13,068.00
0.030	0.270	2376.00	0.170	1.530	13,464.00
0.040	0.360	3168.00	0.175	1.575	13,860.00
0.050	0.450	3960.00	0.180	1.620	14,256.00
0.060	0.540	4752.00	0.185	1.665	14,652.00
0.070	0.630	5544.00	0.190	1.710	15,048.00
0.080	0.720	6336.00	0.195	1.755	15,444.00
0.090	0.810	7128.00	0.200	1.800	15,840.00
0.100	0.900	7920.00			
0.105	0.945	8316.00			
0.110	0.990	8712.00			

NEW METHOD OF STREET PAVING IN HAMBURG

By HENRY H. MORGAN

The so-called Kleinpflaster system for armoring roads has come into extensive use in Germany and other parts of Europe during the past few years, and experience has shown that roads laid with small granite blocks under this system have many advantages. It is far cleaner than other armors, and roads laid therewith are particularly free from dust and dirt, and during wet and damp weather the danger to horses from slipping is reduced to a minimum on account of the joints being so close together. The finished surface is smooth and well adapted for both light and heavy traffic. As a rule, the road once laid requires no maintenance.

The granite blocks used are cut by machines in the required shape and are covered by patents held by the Bornholm Granite Co. The cost of armoring roads with the Kleinpflaster Granite Co. The cost of armoring roads with Kleinpflaster system in Germany, including all necessary work, amounts to $1.58 per square metre (1.196 square yards), and the life of the road is about 20 years where traffic is heavy and 30 years where traffic is light.

In a small pamphlet written by Ferdinand Weiller upon the Kleinpflaster system the following description of the method of laying the road is given:

"First, the old macadam is carefully leveled and rolled. In the absence of an old macadam, one may lay a foundation of concrete 4 to 6 in. in depth. The small stones of approximately cubical shape are placed in position on a bed of sand and pressed tight against each other so as to form a kind of rough mosaic. * * * The subsoil contributes to a great extent to the solidity of the pavement, which, laid in a solid foundation, will last accordingly. The old road should be carefully leveled and rolled or rammed so as to form a solid and water-tight surface with very little camber. A perfect smoothness of the surface is of great importance, as every unevenness of the same will be visible in the plaster and should consequently be removed, the surface being given a camber of one-fiftieth of the width of the road, or even less in flat and broad streets in towns, and then finally rolled by a steam roller."

Sand is spread over the finished foundation to a depth of about ½ in. to bring up the shallow stones to the level of those of full depth. Only coarse-grained sand, without any earthy substance, or fine gravel is fit for this purpose.

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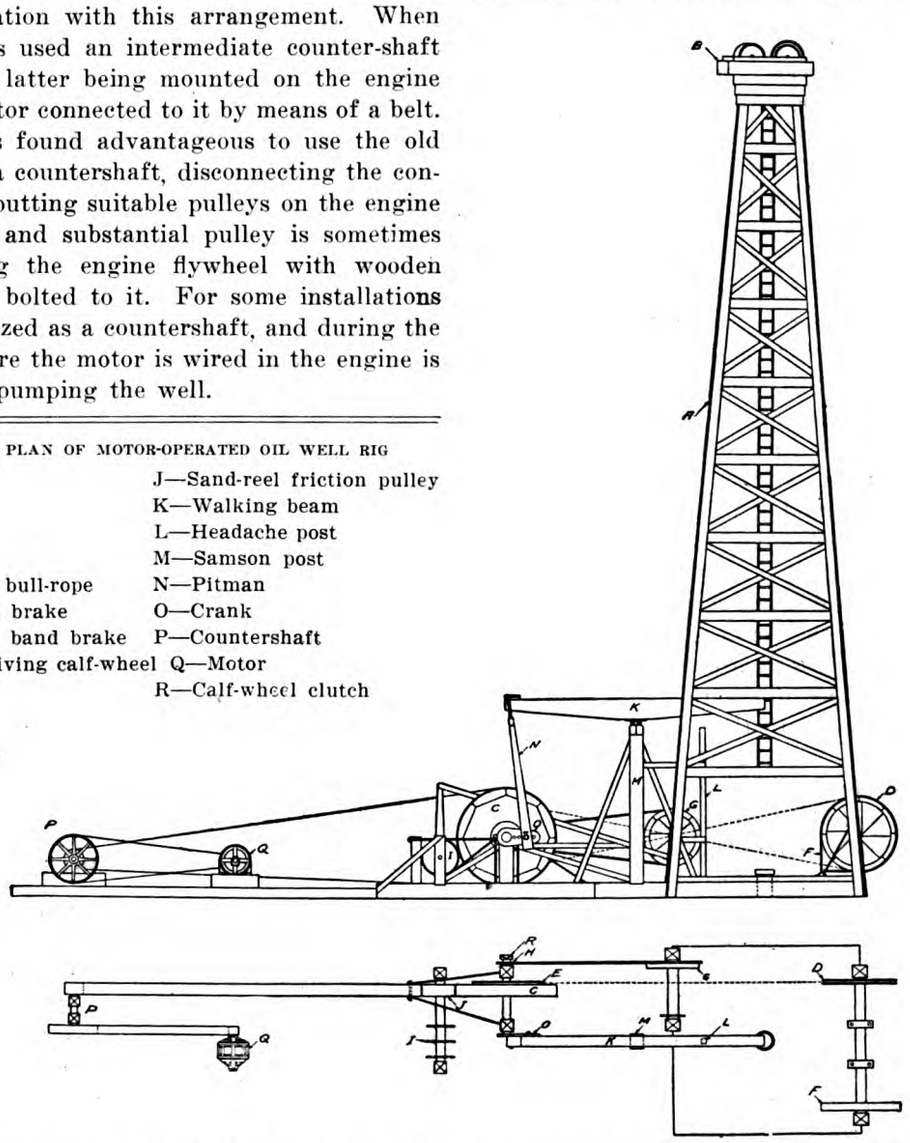
Drilling and Pumping Oil Wells by Electricity*

By W. G. TAYLOR†

The oil well pumping motor installations are of two general types, belted and back-geared, by far the larger proportion of them being belted because of their more quiet running qualities. The back-geared motor is generally mounted on the old engine block and the back-shaft belted directly to the band-wheel, which is a typical installation with this arrangement. When a belted motor is used an intermediate counter-shaft is necessary, the latter being mounted on the engine block and the motor connected to it by means of a belt. Occasionally it is found advantageous to use the old steam engine as a countershaft, disconnecting the connecting-rod and putting suitable pulleys on the engine shaft. A cheap and substantial pulley is sometimes made by lagging the engine flywheel with wooden sections securely bolted to it. For some installations the engine is utilized as a countershaft, and during the usual period before the motor is wired in the engine is still utilized for pumping the well.

ELEVATION AND PLAN OF MOTOR-OPERATED OIL WELL RIG

A—Derrick
B—Crown block
C—Band-wheel
D—Bull-wheel
E—Rope groove for bull-rope
F—Bull-wheel band brake
G—Calf-wheel with band brake
H—Sprocket for driving calf-wheel
I—Sand-reel
J—Sand-reel friction pulley
K—Walking beam
L—Headache post
M—Samson post
N—Pitman
O—Crank
P—Countershaft
Q—Motor
R—Calf-wheel clutch



There are now two types of induction motors in use for the pumping, pulling, and cleaning duty: the single-speed machine and the two-speed machine. Except in a few cases, both have wound rotors for variable speed, the latter obtainable by means of a controller and secondary rheostat; but the two-speed motor has advantages which cannot be obtained readily by other means, and has therefore gained the higher favor since it was introduced. For both types of motors a synchronous speed of either 900 or 1200 r.p.m. is generally selected as being the best compromise between a motor with too small a pulley and one with a high cost.

In the California fields particularly there is a great necessity for a variable pumping speed, as it is influenced by varying conditions, such as the rate of flow of the oil, the amount of sand accompanying it, the amount of gas or water in the oil, the viscosity of the fluid and the condition of the pump itself. A well is pumped at what the operator considers its maximum economical rate, but this may be limited by the rate at which the oil will flow into the well from the surrounding strata, or by the rapidity with which the rods and plunger will drop in the oil on the return stroke. On the average well the band-wheel speed may vary from 18 to 30 r.p.m. and the motor must consequently be

*From *General Electric Review*, June 1914.

†Power and Mining Engineering Department, General Electric Company.

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capable of a similar range in speed. However, for the hoisting work necessary when 'pulling' the well and cleaning it out, a band-wheel speed of twice this amount is used, and is obtained by changing either the motor pulley or the internal motor connections.

On the single-speed motor the desired hoisting speed can be obtained by putting on a larger motor pulley, which must, however, be replaced by the small one for pumping again. This change of pulleys is so irksome to the oil men that it is seldom made, and in many cases where it is tried the pulleys are soon damaged. The slow hoisting speed obtained with the small pulley materially lengthens the time required to 'pull' the well and put it back 'on the beam,' and this means loss of production to the operator. An expedient for obtaining high hoisting speed is to lag the bull-wheel shaft on which the line is wound. This greatly increases the strain on the rig and for that reason is not considered a safe method by most operators. Furthermore, it does not increase the speed of the sand-reel and thus much time is lost when hoisting the bailer.

Another operation which is impossible, unless the motor pulley is changed on the single-speed motor, is 'shaking up' a well. When sand gets in, it very frequently clogs the pump-valves, but by speeding up the walking-beam sufficiently they may often be cleared without resorting to the expensive process of pulling the well. On the other hand, if the motor is shut down long enough to change the pulley, the well in the meantime may sand up completely, making a pulling job absolutely necessary, the work requiring one or two days time depending on the depth of the well, and thus entailing a considerable loss in production. Occasionally a well requires shaking-up several times a day, and it would be obviously impractical to change pulleys each time.

All of these drawbacks have resulted in the extensive adoption of the two-speed variable-speed machine. By a pole-changing switch mounted on the motor frame, the synchronous speed may be instantly changed from 600 r.p.m. to 1200 r.p.m. or back at any time desired, making the high speed at once available for shaping-up, bailing or handling rods and tubing. This method appeals to the oil man on account of its simplicity, and does not have the objections which have been offered to sliding-gear boxes and belt-shifting devices, the operation of which is soon impaired by the wear and tear of heavy duty. On the light redrilling work often necessary when cleaning out a well, the two-speed motor is especially suitable for the wide range of speed and load frequently desired.

A 25-hp. motor, rated 8 hp. on the pumping speed, is the size suitable for the majority of wells. The deeper wells are generally equipped with a 30/15 hp. machine. As indicated by Table 1, the motor on pumping duty is required to deliver an average of 4 hp. but this may vary from 1 to 6 or 7 hp., or higher. A well in the Midway fields in California has been known to require 16 to 17 hp. for a considerable time for pumping, this heavy demand apparently having been due to a heavy flow of sand with the oil. The power input will vary from day to day and even from hour to hour, and may increase considerably in a short time when the well is sanding up. For this reason the motors are given the liberal ratings stated.

TABLE I.—POWER REQUIRED FOR PUMPING 213 OIL WELLS IN CALIFORNIA

	Bbl. per well per day.	Depth of wells.	Kw.-hr. per well per day.	Kw.-hr. per bbl. pumped.
Maximum	230	3110	123.4	5.843
Minimum	10	900	27.7	0.414
Average	122	1430	80.8	0.683

For handling rods and tubing the motor may be required to deliver from 35 to 80 hp. for short periods on the average well, and even higher in some cases, especially in emergencies and on some of the special operations which are occasionally necessary to maintain the well as a good producer. This is many times greater than the power required for pumping, but it has been successfully obtained by designing the machines with a maximum momentary overload capacity of 300 to 450% of their high speed rating.

As pumping is a continuous day and night load, good efficiency and power-factor on this work are of importance to the consumer and power company. To obtain these on the single-speed motor the windings are arranged to be Y-connected for pumping and delta-connected for pulling, the change being made by a double-throw switch on the motor. The rated capacity is thus increased in the ratio of 1 to 3, and excellent characteristics are obtained on either connection. On the two-speed machines it has already been mentioned that the pole-changing switch accomplishes both a change in speed and capacity, and this change in like manner produces the good characteristics particularly desired when pumping.

Motor Control for Producing Wells

The controller and rheostat are located near the motor rather than at the derrick, and the former is operated by a rope wheel instead of a handle, with a wire rope running to a similar wheel on the 'headache-post' in the derrick within easy reach of the operator, and in all respects similar to the throttle control of the steam engine. But as all speed variation and reversing is done by the controller, the reverse lever used with steam engines and gas engines is not required, so that the operator has less effort in controlling the motive power and can give better attention to the work at the well.

In addition to the drum controller and rheostat, the equipment is provided with a wall-mounted oil switch with inverse time limit overload trip coils and low-voltage release. Motor protection is required on either its low or its high rating, and is obtained by the use of double-wound overload trip coils so interlocked with the pole-changing switch on the motor that the proper

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protection is automatically obtained for either connection of the motor. The method of doing this will be at once seen by reference to the wiring diagram shown.

The work of pulling out rods and tubing as well as replacing them requires that they be unjointed and handled generally in 60 ft. lengths, and occasionally in 20 ft. lengths, and this involves considerable manipulation by the motor with frequent reversals at high speed. The best results are obtained by making use of the high torque capacity of the motor, the full benefit of which is obtained on the intermediate controller points. A number of equipments are now provided with a device which entirely relieves the operator of the necessity of keeping this matter in mind on every reversal, as it automatically stops the controller at the most advantageous point until the input has fallen to a value at which the remainder of the resistance is no longer necessary in circuit. The device also acts as a protection to the motor, as it lowers considerably the average current input while reversing.

Counterbalances

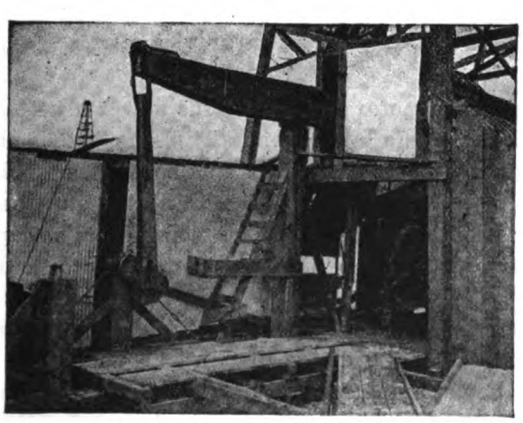
With the advent of the electric motor in the oilfields and the ease of measuring the power input, attention was directed to some economies which could be effected by minor changes in the rig. The chief improvement was the use of a weight to counterbalance the rods on the beam and thus relieve the motor of the necessity of hoisting the full weight of rods on each stroke. The usual type of counterbalance is shown below. It is installed at a nominal cost, and tests on a large number in use show a saving in power of 8 to 22%, depending upon the depth of the well, weight of rods, etc.

Tail Pumps

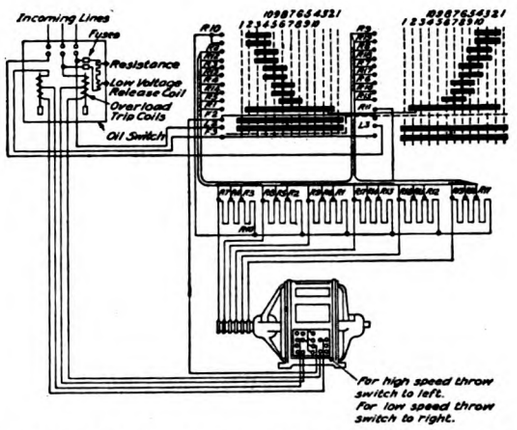
A plunger type of pump is operated from the tail-end of the beam, frequently used for transferring oil from sump to the storage tank or pipe-line. Such a pump increases the power demand from the motor approximately 1.5 hp. under average conditions.

Cost of Pumping, Pulling, and Cleaning

The greatly diversified conditions encountered in the oilfields cause a wide variation in the costs of



MOTOR-DRIVEN RIG SHOWING COUNTERBALANCE.



GENERAL CONNECTIONS FOR TWO-SPEED PUMPING MOTOR.

operation, though these check closely for similar conditions. The depth of well, the quantity and rate of production, the size of pump, the distance between wells, the number of wells operated, and the gravity of the oil, all have their influence. In general, pumping a well with a steam engine requires the following items per well per day:

Fuel oil	3½ to 10 bbl.
Water	25 to 80 bbl.
Lubricating oil, waste, packing, etc.	15 to 40c.
(the higher figure is for gas-engines)	
Repairs to boilers and engines	20 to 40c.

With electric drive the requirements per well per day are about as follows:

Electric power	45 to 200 kw.-hr.
Water	1 to 20 bbl.
Lubricating oil	1 to 3c.
Repairs to motors, transformers, and transmission lines	3 to 6c.

These figures take no account of the cost of labor, which varies greatly even when other conditions are similar. In general one pumper can look after 8 to 12 gas or steam engines or 15 to 20 motors.

Tables 2, 3, 4, and 5 give actual comparative operating costs for a considerable range of conditions and indicate the excellent results being obtained. The figures are all for wells on the beam and operated by individual motors. In the three latter tables it will be noted that for electric operation a charge is included for fuel and water, this being required for washing and heating the oil, also for domestic purposes, and in some cases for shipping the oil. There are a few leases where steam has been entirely dispensed with, the only water used being for domestic purposes. The oil produced on these properties requires no washing, while motor drive is used for the shipping pumps.

Pumping-Jacks

When the production of several adjacent wells is so low that it is unprofitable to pump them by individual motors, they are operated together by one motor from a central point, providing that they are comparatively free from sand and water troubles. The power-head,

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TABLE II.—COST OF ELECTRIC POWER FOR PUMPING WELLS ON SEVERAL PROPERTIES IN THE CALIFORNIA OILFIELDS

No. of wells.	Average depth.	Rate per Kw.-hr.	Cost per well per day.
4	800	$0.015	$0.80
2	950	0.015	0.65
15	1000	0.015	0.71
..	1100	0.015	1.08
2	1100	0.015	1.21
..	1400	0.015	1.05
1	1500	0.015	1.13
62	1600	0.01	0.69
1	1700	0.015	1.11
110	750-2700	0.01	0.84

TABLE III.—COST OF PUMPING 8 WELLS, DEPTH 1000 TO 2800 FEET, IN THE CALIFORNIA OILFIELDS

	Steam operation.		Electric operation.	
	Sept. 1912.	Oct. 1912.	Jan. 1913.	Feb. 1913.
Water	$ 449.99	$ 457.83	$ 71.00	$ 53.90
Fuel, oil at 50c per bbl.	469.00	305.50	.....	.....
Fuel and electric power at 1½c. per kw.-hr...	.....	.....	340.00	329.90
Labor	448.00	448.00	450.00	383.50
Boiler compound and lubricating oil	30.00	30.00	.....	.....
Lubricating oil	.....	.....	17.50	17.50
Totals	$1,396.99	$1,241.30	$863.50	$784.80

Average per well per day—steam.....$5.41
Average per well per day—electricity 3.49
Saving by electricity over steam $1.92 per well per day.

TABLE IV.—COST OF PUMPING 12 WELLS, AVERAGE DEPTH 1100 FEET, OIL 15.5° BAUMÉ, CALIFORNIA OILFIELDS

	Per well per day. Steam.	Electricity.
Labor pumping	$1.15	$1.18
Electric power at 1½c. per kw.-hr.....	....	1.07
Fuel oil	1.47	0.42
Water	1.95	0.95
Repairs to boilers and engines.....	0.25	0.06
Repairs to motors, transformers and power lines	None to Date.	None to Date.
Oil, waste and packing	0.27	0.17
Totals	$5.09	$3.85

Saving by electricity over steam, $1.24 per well per day.

TABLE V.—COST OF PUMPING 107 WELLS, AVERAGE DEPTH 800 FEET, OIL 13.5° BAUMÉ, CALIFORNIA OILFIELDS

	Per well per day. Steam.	Electricity.
Maintenance pipe-lines, wells, pumps, rigs, boilers, motors, transformers, and transmission lines	$0.95	$0.70*
Labor, including pumpers, boiler men, electricians and well-gang.....	0.65	0.45
Fuel oil at 35c. per bbl.....	1.17	0.12
Water, waste, and lubricating oil.....	0.52	0.13
Electric power at 1c. per kw.-hr.....	...	0.57
Totals	$3.29	$1.97

Saving by electricity over steam $1.32 per well per day.
*Estimated repairs are added for electrical equipment, as there were none for period covered.

TABLE VI.—POWER REQUIRED FOR PUMPING OIL WELLS BY PUMPING-JACKS IN CALIFORNIA OILFIELDS

No. of motors.	No. of wells.	Average kw.-hr. per well per day.	Kw.-hr. per bbl. pumped.
1	7	39.7	2.52
1	8	37.6	2.30
1	14	31.9	1.41
1	8	37.1	1.67
1	8	29.1	...
1	8	30.4	...
1	9	28.2	...
1	12	26.3	...
1	23	15.7	...
1	22	17.2	1.43

TABLE VII.—COST OF ELECTRIC POWER FOR DRILLING IN CALIFORNIA OILFIELDS

POWER RATE, 1.5C. PER KW.-HR.

Depth of well, feet.	Cost of power per foot drilled.
735	$0.1074
1495	0.1025
945	0.0915
1356	0.1060
824	0.0570
732	0.1040
1175	0.0848

as shown below, carries one or more eccentrics, to the yokes of which are attached cables or rods extending to a bell-crank or 'pumping-jack' at each well, and by this means imparting the vertical reciprocating motion to the sucker rods. An ordinary constant speed

POWER-HEAD DRIVEN BY 20-HP. MOTOR.

squirrel cage motor is belted to the power-head through a jack-shaft, the latter generally being provided with a friction clutch. A quarter-turn belt connects the latter with the power-head. The outfit is simple and the installation very cheap as no special electrical apparatus is required other than the standard motor and compensator for starting it. When the well is cleaned a portable hoisting equipment is employed, consisting of an electrically driven reel mounted on wheels.

The power required for pumping wells by this method depends considerably upon the effectiveness with which the wells are balanced against each other, and is affect-

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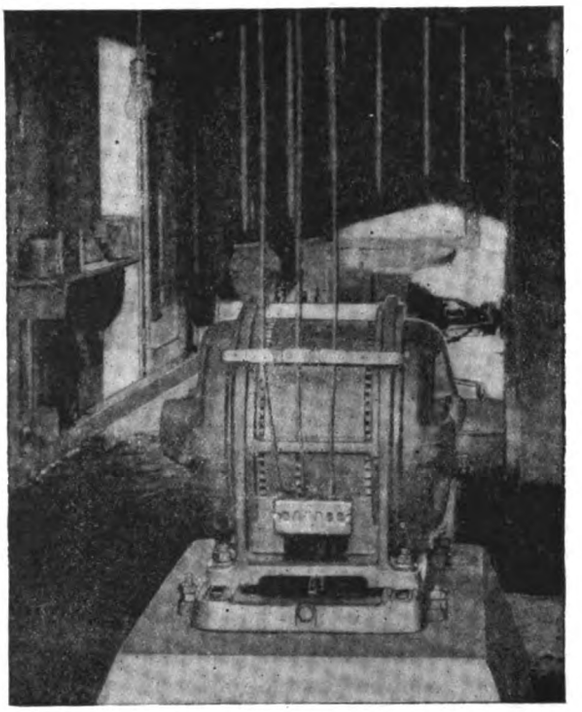
ed also by variations in the depth of the wells, the height to which the fluid rises in the well, the gravity of the oil, the diameter of tubing used and the speed of pumping, as well as the general condition of the wells with respect to sand, gas and water content. A low pumping speed is maintained, generally from 10 to 20 strokes per minute. In Table 6 are given figures taken from the records of several oil companies in California which give a general indication of the motor capacity necessary.

Motors for Drilling

The two principal modern methods of drilling oil wells are the standard cable-tool method and the rotary process, although in a few instances a combination of these two is used. In cable drilling a heavy stem and bit are suspended from the walking-beam by a steel wire or manila rope, and are raised and dropped on the bottom by the movement of the beam. The drillings are mixed with water in the hole and are removed at intervals by a bailer. In the rotary process a bit is located at the lower end of a rotating column of pipe, which is lowered into the well as drilling progresses. The pipe is held and turned by a turntable in the usual way. By means of the so-called 'slush-pump' a mixture of thin mud is circulated down through the stem and up outside of it, serving to wash out the drillings and plaster up the sides of the hole to prevent caving.

As drilling proceeds the well is lined with iron or steel casing unless the strata passed through are so firm that no caving will occur. The casing is inserted in approximately 20-ft. lengths, screwed together, and its handling imposes heavy duty on the drilling motor. As has been mentioned, the calf-wheel is used for this casing work. In lowering a string of casing into a well the friction of the sides of the hole caused by the pressure of the surrounding formations may so impede it as to prevent it from sinking farther until relieved by 'spudding' the casing. This consists in repeatedly raising and lowering it a few feet until a clear passage is obtained, and requires a very liberal intermittent overload capacity in the motor. Its ability to exert a high torque in an emergency is often the means of freeing a string of casing which may have become 'frozen', and which might otherwise have to be 'landed' in the hole, and thus necessitate drilling being resumed with a smaller string.

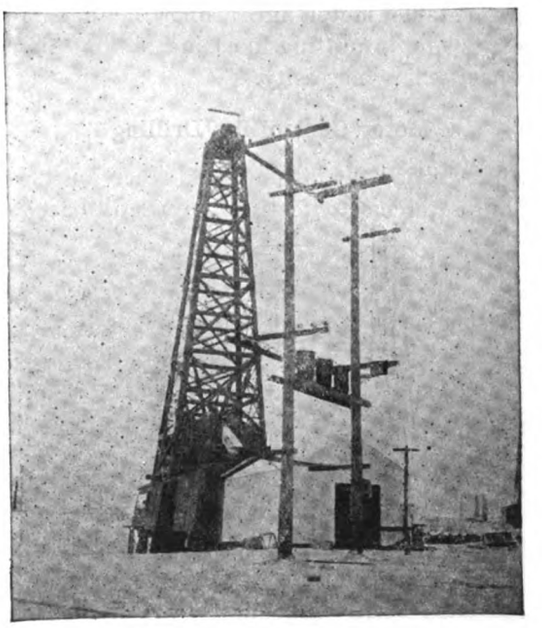
On account of the heavy strains to which the equipment is subjected, the motor for cable drilling is preferred without backgears, and a belted countershaft is therefore used as with pumping equipments. A few installations have been made using a two-speed change-gear countershaft to obtain more economical speed variation, but they have nearly all been discarded because of their rapid depreciation under the severe service. It has also been found that the operators frequently failed to make use of the device because of the time and trouble involved, and furthermore that the



35-HP. CONSTANT-SPEED MOTOR DRIVING POWER HEAD FOR PUMPING 23 WELLS.

tremendous pull obtainable with the low gear was more than the average rig and casing could withstand without injury.

The range in speed required is approximately the same as for producing wells and is obtained by insertion of resistance in the rotor circuit. Other methods requiring more expensive equipment have been tried, but the standard type of variable speed slip-ring motor with the special control described in a subsequent paragraph has met the most general favor. It is



MIDWAY PACIFIC WELL AT FELLOWS, DEPTH 1900 FT., DRILLED BY ELECTRIC POWER.

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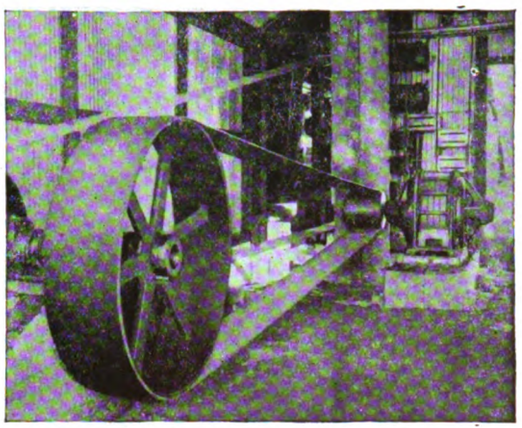


50-HP. DRILLING MOTOR OPERATING STANDARD CABLE TOOLS.

natural that this should be the case, as the various operations follow so closely upon each other during the day that the driller is seldom willing to take the trouble to throw switches or shift gears each time, and will not do so if he can get fair results without it.

The power required for the numerous operations in standard drilling varies considerably. Drilling itself is a fairly steady load on the motor, while the load imposed by the other operations, especially the manipulation of casing, is very intermittent in character, requiring high torque and frequent reversals. A 50-hp. machine has been found to have sufficient capacity for all drilling work on most wells of moderate depth, but 75 hp. may be necessary in many cases, particularly for greater depths. The size of motor in any specific case depends, as in pumping, upon the local conditions encountered.

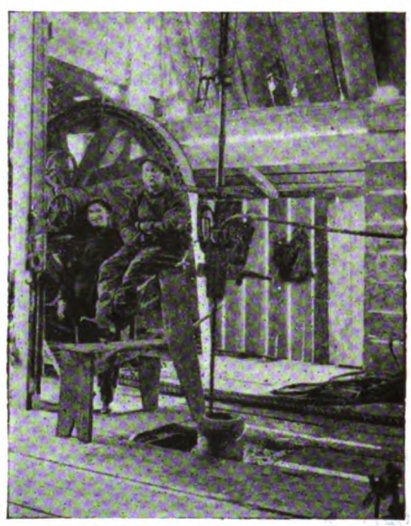
For the rotary process the same type of motor used in cable drilling is well suited for driving the turntable and also the slush-pump. Heavy duty is required of the turntable motor in raising the drill-stem to change bits, and in putting in casing, so that high overload capacity is a necessity.

Motor Control for Drilling

In cable drilling the bit must fall freely on the down stroke to get the most effective blow, and to accomplish this the motor must slow down when lifting the bit and speed up when dropping it. This 'series characteristic' is obtained by so proportioning the pulleys that some secondary resistance will be in circuit when the motor is operating at the correct drilling speed.

The speed of cable drilling requires a very fine adjustment so that the movement of the beam will accord with the natural period of vibration of the drilling line due to its elasticity, as this period changes with the deepening of the well. Deviation from the right speed will not only result in deadening the movement of the bit but may seriously strain the line and the beam. Some of the first motors installed for this work were equipped with a 10-point controller, but it was found that the speed control was not fine enough. This trouble was overcome on later equipments by supplying an auxiliary controller designed to cut in between points on the main controller. A very smooth control with an infinite number of points may be obtained with a liquid rheostat, but this requires good water and close attention for satisfactory operation, neither of which can be given it under average conditions. For this reason it has been discarded by most California oil men who have tried it, and drum controllers are now given the preference. They are operated by wire ropes extending to the 'headache post' as previously described for producing wells.

INDIAN AND COLONIAL DEVELOPMENT CO. PROPERTY, ELECTRICALLY OPERATED.



ELECTRICALLY OPERATED RIG, AND CREW.

Rotary work also needs a fairly close speed adjustment because of the fact that for each different formation encountered there is a certain speed at which the bit will cut most effectively.

Cost of Drilling

The cost of power is more variable for drilling than for pumping, as it depends upon the amount of trouble encountered and will be particularly high if there is any casing trouble. The figures given in Table 7, which have been determined from the actual power bills for drilling each of the wells in question, are representative of fairly good operating conditions.

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Street Grading With a Revolving Shovel in Los Angeles*

Sullivan, Gabler & Kautz of Los Angeles, have recently completed a grading job on Glendale avenue, on which, despite the shallow cutting, they used a small revolving shovel to splendid advantage. The total yardage amounted to 23,016 cu. yd., bank measure, which was handled between March 10 and April 25, 39½ days in all, including Sundays.

The work was handled in an extremely systematic and efficient manner. C. J. Gabler, a member of the firm, operated the shovel, and made an exceptional record considering the stiff character of the material and the depth of digging.

The shovel, which was an 18-B Bucyrus, equipped with a ⅞-yd. dipper, burned fuel oil. Twelve tanks, or 10,080 gallons were consumed during this period. The oil cost $12 a tank.

Throughout the entire job, Sundays were regularly devoted to washing out the boiler, cleaning the flues and making sundry repairs, which, doubtless accounts to a large degree for the regularity of the output. Although the greater part of the material was classified as earth there was over 7000 yd. of rock and sandstone, besides 2300 yd. of hard adobe clay, which, naturally cut down the capacity of the shovel considerably.

Accurate costs were kept. This was facilitated by an excellent type of log book, or daily report sheets of the shovel performance. We reproduce herewith, a sample sheet.

*From *The Excavating Engineer*, June, 1914.

SULLIVAN, GABLER & KAUTZ — DAILY REPORT OF STEAM SHOVEL

MEN ON STEAM SHOVEL	PAY ROLL NO.	TOTAL HRS.	RATE per hr.	AMT.	MATERIAL	YDS.	PRICE per yd.	AMT.
Engineer								
Fireman								
Pitman								
"					TOTAL EARNINGS		$	
"					Fuel Oil Gals. @	c		
Watchman					Lubr. Oil Gals. @	c		
Miscellaneous					Water-rate per day			
"					Sundries Expense			
"					Pay Roll today			
"					TOTAL EXPENSE			
TOTAL					NET			

General Report of Days Work

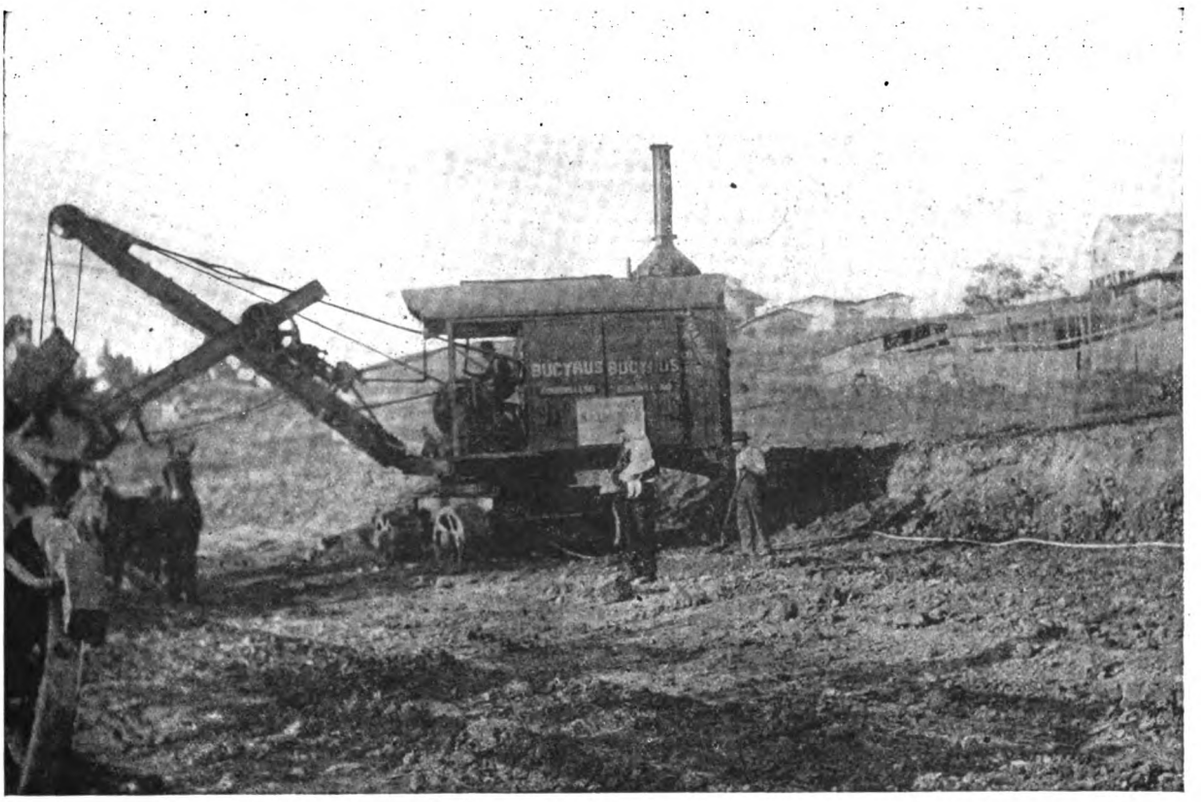
Location of Shovel Shift Date 191

SAMPLE SHEET FROM LOG BOOK.

Each sheet is in duplicate, a white and a yellow copy. The white sheet is perforated. This is filled in at the end of every day by the shovel engineer and turned in, a copy remaining in the book; thus a complete detailed record of every job is kept.

From this log book we are able to produce the following table showing the performance of the shovel on this contract:

Total yardage (bank measure) .....23,016 cu. yd.
Total time under steam .....34½ days.



STEAM-SHOVEL CUTTING ROADS IN LOS ANGELES.

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SHOVEL IN OPERATION.

Lost time including delays for moving, blasting, repairs, etc. ..... 23½ hours.
Average yardage per hour working ..... 67.8 cu. yd.
Average yardage per hour under steam including delays ..... 63.4 cu. yd.
Maximum output per 11 hour day bank measure { 735 wagons / 1000 cu. yd.
Cost of labor, fuel, sundries, etc. ..... 0.024 per cu. yd.
(This does not include Mr. Gabler's time)
Cost of labor, including allowance for engineer. 0.033 per cu. yd.
(Including delays.)

The best week's output was perhaps the first week in April, the record of which we give below:

Date, days.	Hours worked including delays.	No. of wagons.	Estimated yardage bank measure, cu. yd.	Average per hour. cu. yd.
April 1	10	652	900	90
" 2	10	637	850	85
" 3	11	682	1000	82
" 4	11	724	1000	91
" 5	11	577	800	73
" 6	11	662	850	77
" 7	11	735	1000	91
—	—	—	—	—
7	75	4649	6300	84

It might be interesting to note that after the completion of this job, the shovel was moved a distance of about seven miles in 2½ hours by the use of two five-ton automobile trucks. The propelling was done entirely by the trucks at a cost of $2.25 per hour per truck.

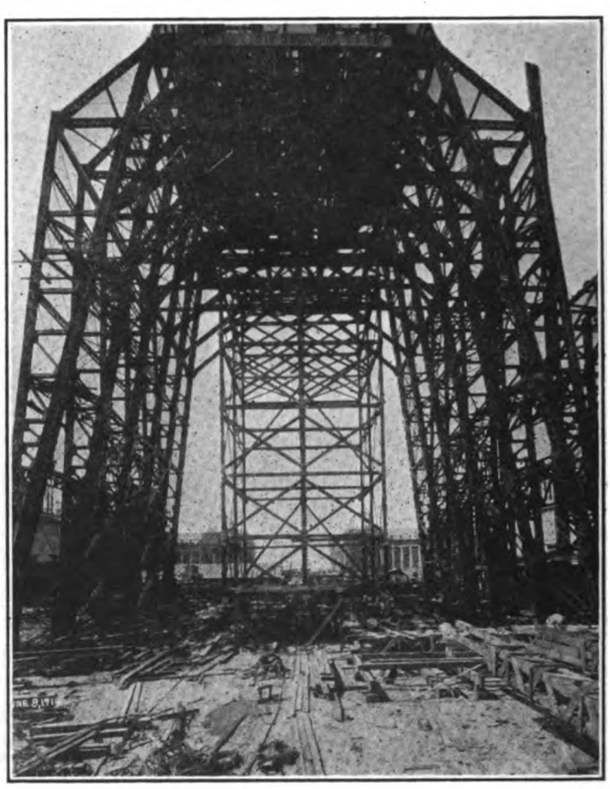
Ordinary cement wash on concrete will not stand the weather. Good results can be obtained by mixing a small quantity of boiled linseed oil with the water used for the cement wash. A quart of boiled oil should be added to 10 gal. of clean water, and this mixture used instead of the plain water in the ordinary way. The most satisfactory method of coating concrete, however, is by means of the cement gun, which gives a perfect bond between the concrete and the gunite coating.

TOWER OF JEWELS AT THE PANAMA-PACIFIC EXPOSITION

Marking the main entrance to the Panama-Pacific International Exposition and the centre of the main group of exhibit palaces is the lofty pyramid of steel, now nearing completion, that is to compose the Tower of Jewels. The structure embodies as many wonders as any other on the exposition grounds. In addition to being one of the architectural and engineering features of the exposition it is to be the exposition landmark, so to speak, being visible over the hill tops from all parts of San Francisco and for many miles in all directions.

This tower is to be 435 ft. in height and surmounted with a great sphere, 17 ft. in diameter, illuminated from within and supported by eight figures of Atlas. The exterior of the edifice is to be ornamented with 150,000 glass jewels, which, with the play of searchlights upon them, will furnish one of the most spectacular illuminative features of the entire exposition. Some 1500 tons of steel and 1,600,000 board ft. of lumber go into the construction of the tower. There will be seven balconies, three of them with colonnades, at different altitudes.

Thirteen miles of piling support concrete foundations of the tower. Owing to the nature of the ground it was necessary to use a water jet in sinking most of the piling. The six two-hinged arches that form the base of the tower and its main arch are tied across the bottom and rest on twelve ball and socket joints 3 ft. diameter, each capable of supporting 1,250,000 pounds.



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Industrial Progress

DEVELOPMENT OF EQUIPMENT FOR MIXING AND LAYING CONCRETE ON STREETS AND HIGHWAYS

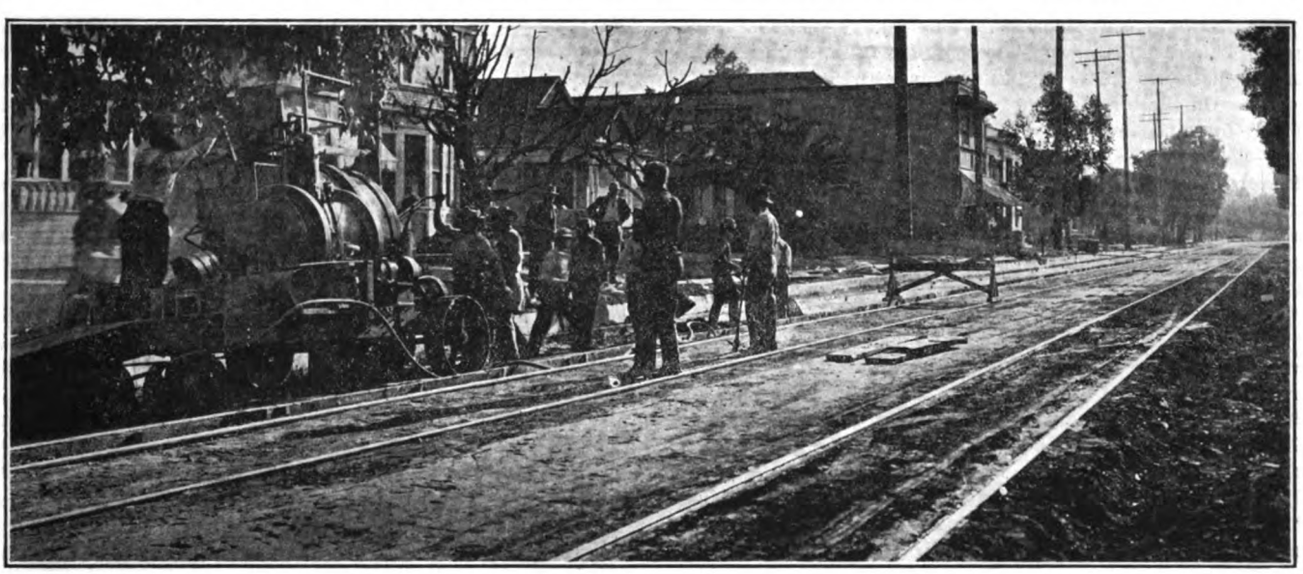
When concrete first made its appearance as a base for streets and highways there was no special equipment on the market for handling concrete for this particular purpose. For this first work the ordinary type of building mixer was used. The mixer was set up at a street intersection and the concrete after being discharged into horse drawn two-wheeled carts was hauled onto the street and dumped wherever required. However, this method of handling the concrete proved rather slow and expensive and as concrete became more generally used for street and road work and competition became keener the contractors looked about for a more efficient and economical way of mixing and laying the concrete.

As the mixer manufacturers seemed to be rather slow in turning out a type of concrete mixer applicable to this particular use of concrete, the large paving firms constructed for themselves a mixer particularly adapted to laying concrete base. These home-made mixers consisted of a building mixer drum mounted on trucks in such a way as to make the mixer end-loading and discharging, which was quite different from the building mixers which were and are side-loading and discharging. To load these mixers, runways or runboards from 14 to 18 ft. in length were added, up which the wheel-barrows loaded with the sand and stone were wheeled. These wheel-barrows were then dumped directly into the drum. The concrete was discharged directly from the drum onto the sub-grade or planks. From there it was carried by men with large scoops and deposited in place. These home made runboard mixers had their own traction and were moved down the street as fast as the concrete was laid behind them. The mixers did good work, laying as much as 14,000 sq. ft. of 5-in. base per 9-hr. day. But on a wide street they required a crew of nearly 40 men. Over 20 of these men were used in carrying and spreading the concrete.

The mixer manufacturers, realizing that their standard side-loading and discharging mixers would no longer do for street or road work, took their standard building mixers and turned them endwise on their trucks. They added to these mixers their standard building mixer skip and a propelling mechanism. In order to do away with the large number of men used on the back end of the mixer for carrying and spreading the concrete, these mixers were equipped with open chutes down which the concrete flowed by gravity. These chutes could not be made very long, for the height of the discharge was not very great. Later, the drum of the mixer was raised further from the ground so that longer chutes could be used. But still these mixers were limited in their output owing to the fact that the narrow pivoted skip delayed the wheel-barrow men and the gravity chute was adapted to use on streets that were not over 25 or 30 ft. in width. Moreover, with a gravity chute a number of difficulties developed, for if the concrete was mixed at all stiff it would not flow and had to be hoed or raked down the chute. For this reason, the tendency was to mix the concrete too wet in order to be sure that it would flow down the gravity chute quickly. This caused a separation of the materials and made it hard to keep the concrete up to the crown.

Certain structural defects also appeared. Owing to the mixer never being level, the frame was always being more or less twisted and strained which caused the gears to bind. As the drum had been raised very high from the ground, the pivoted skip had to be lengthened greatly. When this long heavy skip was raised, the strain on the entire machine became very great and the skip was dangerous to the men working in front of the mixer. Also as the skip was off to one side, the mixer could not 'straddle' the crown and keep the skip in the centre of the road. The consequence was that when the skip was kept in the centre of the road, the entire mixer leaned to one side. The output of these mixers was not much greater than with the old runboard mixers, but owing to the saving of the men in carrying and spreading the concrete, there was a decrease in labor. But even this was limited, just as the use of the gravity chute is limited to narrow work.

About five years ago a large mixer manufacturer decided to build a concrete mixer particularly adapted to concrete street and road work. In order to do this all the building mixer features had to be eliminated. To begin with, larger wheels, deep axles and a deep frame were used to give the high discharge required. These large wheels also decreased the jar on the machine as the machine did not drop into each small depression and required less power to move. In order to keep the machine always level and prevent the gears from binding, the front truck was pivoted vertically as well as horizontally, giving the machine a three-point suspension as is found on road rollers, traction engines, motor trucks, etc. Further, to insure absolutely that the gears would not get out of line, one large, solid, continuous bearing was used and to this bearing



RUNBOARD TYPE OF PAVING MIXER, WITH SMALL PIVOTED DISCHARGE CHUTE.

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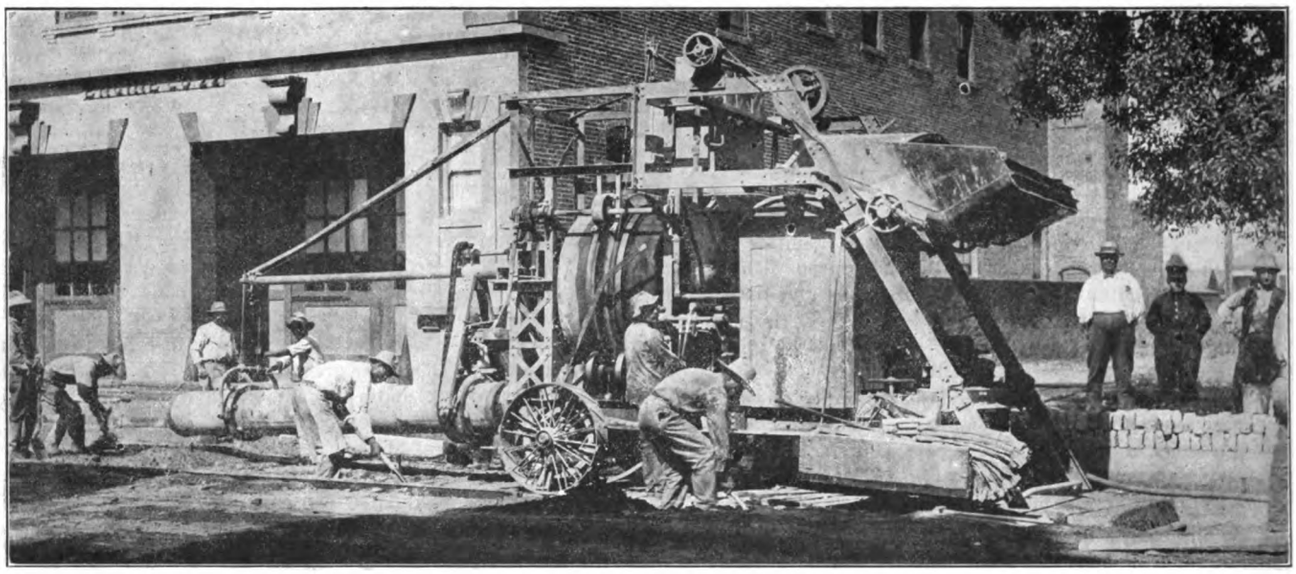

SMITH-CHICAGO PAVER IN ACTION ON SOUTH MAIN STREET, LOS ANGELES.

every gear on the machine is attached. A differential was also used so as to equalize the strain on the gears. The engine was placed in the centre of the machine where it could not be hit by any passing team, and being on the centre it is apt to receive less vibration than if set to one side. The narrow long building skip was discarded entirely and in its place a short very wide loading skip operating on tracks was substituted. This skip was made 8 ft. wide at the bottom and with a nose 4 ft. wide at the top. This loading skip is over double the width of any pivoted building skip. The object of such a skip was to make it possible to dump three or four wheel-barrows at the same time thus doing away with the delay caused by one or more wheel-barrow men and waiting for the others to dump and get out of the way when a narrow skip is used. The wide nose of the skip permits the load to be discharged into the drum instantaneously. As the skip operates on tracks it does not strain the entire machine when it is lifted, requires less power to be raised than a pivoted skip, and is not dangerous to the men working in front of the mixer.

The mixing drum used is a standard cylindrical drum, the type generally used by manufacturers of non-tilting batch mixers owing to its great efficiency and speed in mixing and discharging concrete.

To distribute the concrete, a long rotary distributor was used. This distributor consists of a pipe 18 in. diameter made in lengths up to 20 ft. This pipe has a slight fall and is revolved. On the inside of the pipe, blades are fastened. These blades force the concrete along the pipe as they revolve, prevent the materials from separating, and make it possible to deliver the concrete in a mixed condition 20 ft. from the mixer. If the concrete happens to be dry or stiff, it is handled very easily by this distributor. As the concrete does not rush out in a pile, as down a gravity chute, or as when dumped from a bucket, but comes out in a constant uniform amount, it is very easy for the spreader men and template men to handle. The feed into the distributor is very fast owing to the large feeding hopper into which the concrete is discharged before entering the rotary. The entire machine is balanced on the centre line so that when the charging skip is in the centre of the road, the mixer straddles the grade and no part of the machine extends beyond the wheels.

That this machine has proved a great success has been demonstrated by a number of actual records and comparative tests.

A Los Angeles paving firm a short time ago carried out a comparative test between this mixer which is known as the Chicago paving mixer and one of the narrow pivoted skip and gravity chute mixers. The test was made on the same street under the same material, labor, and water conditions. The Chicago averaged for the ten days 4000 sq. ft. of 5-in. base more per day. In May a paving firm was able on two days to run with one of these mixers over 21,000 sq. ft. of 5-in. base in 9 hr. using but 9 shovelers and 3 wheelbarrows to charge the mixer. This we understand to be a world's record. This same firm has been working one of its Chicago mixers almost every day for 7 months and the mixer now has a daily average of 16,605 sq. ft. of 5-in. base. This record includes any day on which the mixer was run even if it was only for a part of a day. A number of other users of this machine report daily averages of from 16,000 to 18,000 sq. ft. of 5-in. base on jobs running from 30 to 90 days in length of time. Another paving contractor engaged in subdivision work laid 75,000 sq. ft. of 4-in. base in 3½ days. Still another firm reports of having averaged over 16,000 sq. ft. of 6-in. base per day.

On narrow light highway work this machine has done wonderfully. One contractor engaged in this class of work ran 925 lin. ft. of 18-ft. concrete base 4 in. thick in one day with only 13 men, including foreman and engineer. Another firm reports averaging 620 lin. ft. of 18 and 20-ft. highway 4 in. thick for 32 consecutive days. A number of other contractors have reported averaging between 700 and 800 lin. ft. of 18-ft. highway for a week or 10 days at a time.

Such records and daily averages as the above were not considered possible before. The large output of the Chicago mixer naturally greatly reduces the overhead expense on each job. Costs for just mixing and laying the concrete with the Chicago have been given as low as under 25c. per cu. yd., while under 30c. is not unusual.

The mixer not only appeals to its users from the standpoint of large output and low labor costs, but also because of the smooth, even concrete it turns out due to its rotary distributor. The durability of the machine is also very great owing to the manner in which all unnecessary and undue strains have been eliminated.

PENNSYLVANIA METAL CULVERT CO., of Warren, Pennsylvania, has issued for free distribution an illustrated catalogue of the American ingot iron corrugated culverts, which are practically non-corrosive when exposed to the weather.

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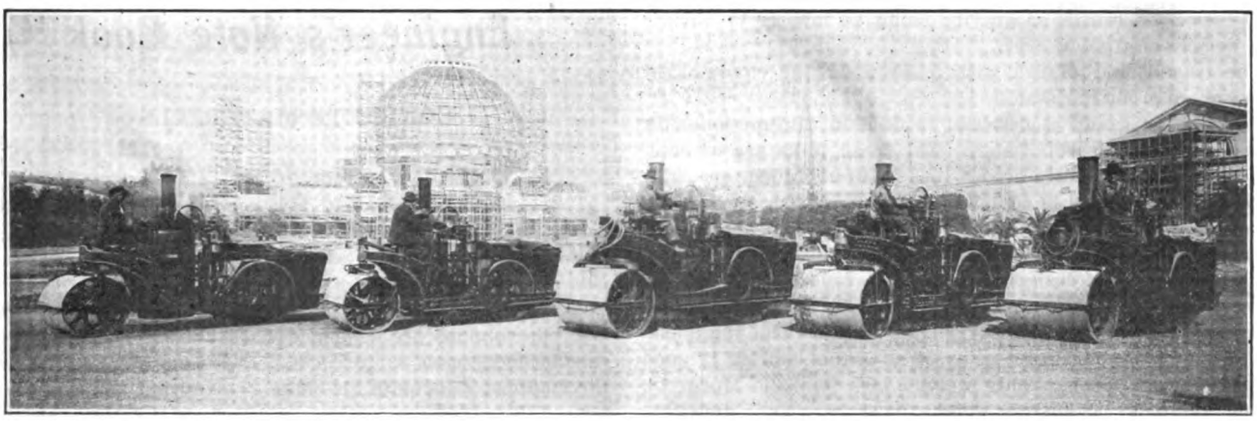


FIG. 2. BUFFALO PITTS ROAD ROLLERS AT PANAMA-PACIFIC EXPOSITION.

PAVEMENTS IN THE PANAMA-PACIFIC EXPOSITION GROUNDS

Much publicity has been given to the construction of the buildings for the Panama-Pacific International Exposition, but it is doubtful if many who read of the construction work in general, have given any thought to the roadways being built within the grounds.

The quantity of road and street construction and paving can hardly be appreciated without resorting to figures, which at first might appear to be overdrawn but which will only go to show how extensive are the Exposition grounds.

The total area of the main streets and driveways is approximately 4,000,000 sq. ft. This represents a total length of paved roadway 16 ft. in width which would extend from San Francisco to San Jose, a distance of 47 miles, and which in reality would be substantially the same as the area of the State Highway between the two cities.

As the Exposition period is to be but ten months, water bound macadam was adopted as a base for nearly all of the road work. Of the total area of the pavement, 2,100,000 sq. ft. is of water bound macadam, 6 to 8 in. thick. This represents 25 miles in length, or a little over one-half the entire surface paved. There is 500,000 sq. ft. of 1½-in. sheet asphalt pavement laid over a base of macadam which averages 7 in. thick. The remaining 1,400,000 sq. ft. of surface is covered with 1-in. sheet asphalt over the same type of macadam base. The total area covered by asphalt would be represented by a standard 16-ft. roadway 24 miles in length.

The construction of these pavements has covered a period of many months and many difficult engineering problems have been encountered. Owing to the peculiar soil conditions, great care was given to the preparation of the sub-grade and the subsequent laying of the macadam base. In many cases it was found necessary to use very high compression to secure a firm base, and for this work the Engineering Department has used a special 10-ton steam tandem roller, having a divided drive roll, thus securing a compression of over 400 lb. to the inch. This roller is shown in Fig. 1. Fig. 2 shows the five Buffalo Pitts steam tandem rollers being used by the Exposition Company in all their pavement construction.

Under the supervision of their own engineering department, the Exposition Company has constructed all the sub-grades, water bound macadam and macadam base, representing over 3,000,000 cu. ft. of macadam work. The sheet asphalt surface of 1,900,000 sq. ft. is being laid under contract.

THE YUBA BALL-TREAD TRACTOR

The Yuba 'Ball-Tread' tractor is built at Marysville, California, by the Yuba Construction Co. The manufacturers claim that owing to the special nature of the design and construction it is the lightest, most durable, and most easily operated flat-track machine on the market. The essential features of its design are the transmission by which the two treads are handled independently, and the ball-bearing track. Two reversible clutches enable the operator to run one tread forward while reversing the other tread, rendering it possible for the tractor to make a complete revolution in its own length.

By running on chilled cast iron balls, it has been found possible absolutely to prevent the track coming off the machine, and inasmuch as the balls can take the weight at any angle, the machine can work successfully on hillsides, on heavily crowned

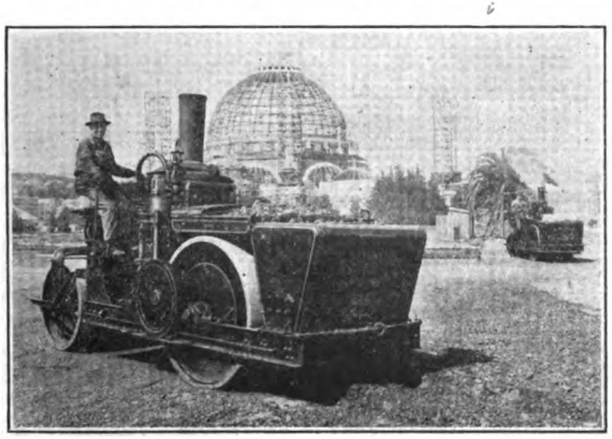
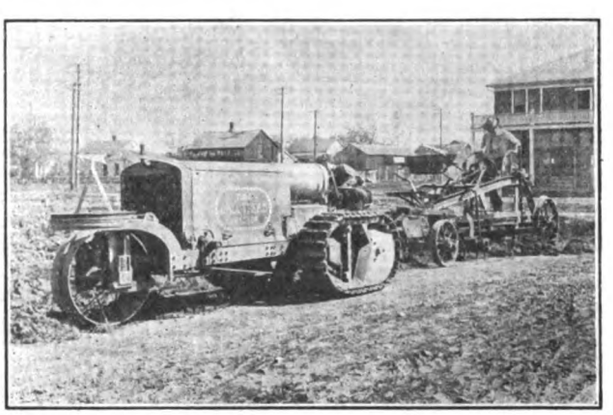


FIG. 1. BUFFALO PITTS ROAD ROLLER.



YUBA BALL-TREAD TRACTOR.

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roads, etc., its centre of gravity being so low as to obviate any danger of tipping over.

The tractor is equipped with a lever for the changing of speed gears from the seat.

The highest grade of material is used in conjunction with these novel features of design. The tread links are of manganese steel; the shafts are of nickel chrome steel, specially treated. The tractor is completely equipped with Hyatt high duty roller bearings. Very little cast iron is used, the tractor being practically of steel throughout.

These features of design and the high-grade of material employed, have enabled the manufacturers to keep the weight of their tractor down to a surprising degree. The small machine, which is guaranteed to exert an actual pull of 12 good horses at the draw-bar, only weighs 7600 lb. The Model 18, which replaces 18 horses, weighs 8900 lb. The Model 12 tractor is only 14 ft. 7 in. long, 5 ft. 9 in. wide, and 4 ft. 9 in. high. No. 1 engine distillate is used for fuel for both machines.

A special machine is now being built which is designed for work on hard or irregular road surfaces and which will be used by contractors and mines. This machine in both sizes is only 5 ft. 3 in. wide on the ground—about the width of a standard wagon. The manufacturers claim that its tread is practically indestructible, being composed of four parts, the manganese link, case hardened pin, chilled cast iron balls, and integral manganese tread casting. This machine is by far the narrowest flat-track machine ever built and the Yuba Construction Co. reports a wide interest in this new model.

American Blower Co. has issued Bulletin 35, Series 1, 'The Pitot Tube and Fan Testing.' This is not a trade catalogue and offers nothing for sale, but is an engineering treatise with carefully compiled data taken from tests showing the correct method of Pitot tube testing and the application of the Pitot tube in fan testing. As such it is a very valuable publication to mechanical engineers and will be a decided acquisition to any technical library.

Central Foundry Co., 90 West street, New York, has issued a catalogue describing valve service and roadway boxes.

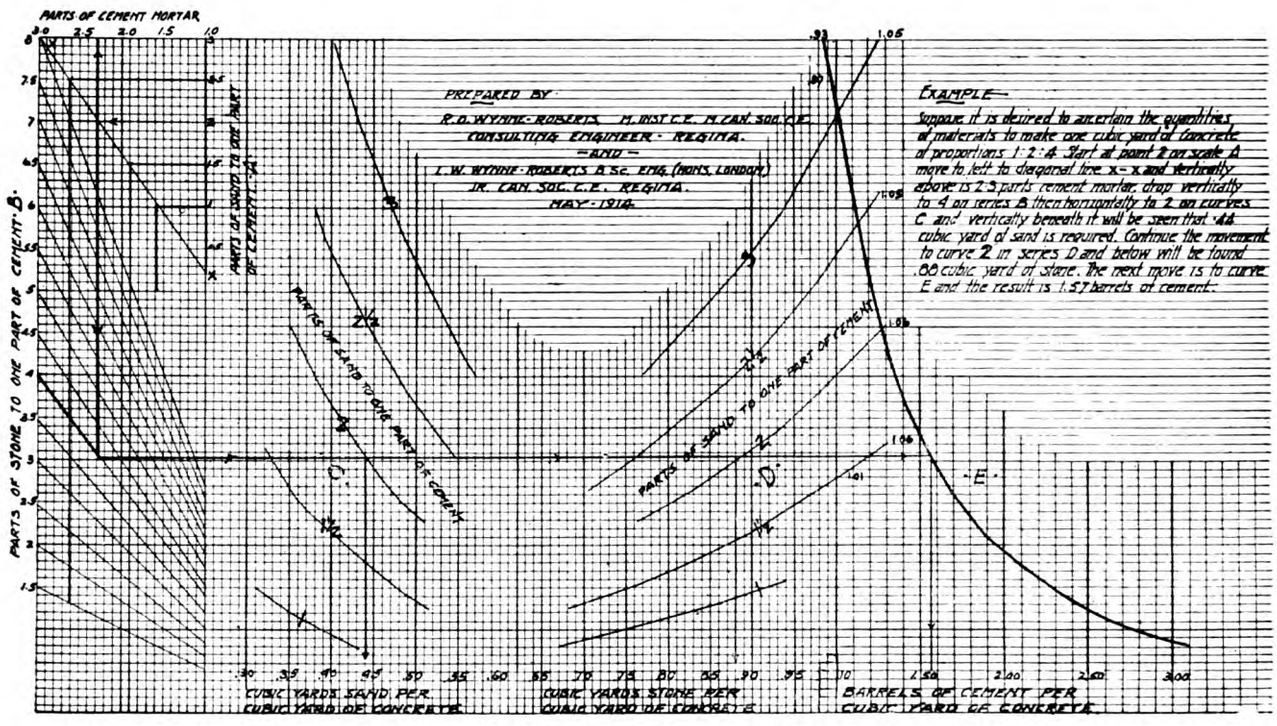
Engineer's Note Book

CONCRETE MATERIALS*

By R. O. Wynne-Roberts

Those who have frequent occasion to prepare the estimated cost of concrete structures find it useful to have data as to the quantities of materials that are required to make one cubic yard of concrete of different proportions. There are tables given by various authors which are convenient for office use, but volumes are seldom carried about, and consequently calculations, even approximate, are usually deferred until the engineer returns to his office. The author has experienced a need for a diagram which will afford the information as to the quantities of cement, sand, and stone necessary per cubic yard of concrete in place, and set to build one. The accompanying diagram is believed to be very simple and easily understood, and is applicable for concretes whose proportions range from 1:1:1½ to 1:3:8, which will doubtless suffice for practically all classes of work. The curves are derived mostly from tables in Taylor and Thompson's book on concrete and therefore no claim is made for originality of data, but the diagram is original. In the top left-hand corner is given the volume of cement mortar produced by mixing various proportions of cement and sand. When any proportions of cement, sand, and stone are specified, all that is necessary is to start on scale A with the given number for sand, trace that line to the left as far as the diagonal line X—X, then move vertically downward until the line crosses the sloping line giving the number for stone, and afterward move to the right, intersecting the given sand volumes in series C and D and also the curve E, and vertically beneath each intersection will be found the quantities of sand, stone, and cement respectively. An example is given in the diagram to show how the quantities of concrete ingredients for a proportion of 1:2:4 are found. The same procedure is to be followed in other cases.

*From *The Canadian Engineer*, May 21, 1914.



CURVE SHOWING QUANTITIES OF MATERIALS FOR MAKING CONCRETE AGGREGATE.

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Book Reviews

PRACTICAL TREATISE ON SUB-AQUEOUS FOUNDATIONS. By Chas. Evan Fowler. John Wiley & Sons, New York. P. 793. Index. For sale by the *Mining and Scientific Press*, San Francisco. Price $7.50.

This is the third edition of Mr. Fowler's work, the first having been published in 1898 under the title of 'The Coffer-dam Process for Piers.' The second edition was published in 1904 under the title of 'The Ordinary Foundations Including the Coffer-dam Process for Piers.' As is indicated by the title, this work embodies not only a revision of the earlier editions, but includes also a general review of the literature on the subject in order that the subject matter might be as comprehensive as possible. The author's personal experience of over 26 years with special reference to practical examples has been embodied in this work. This is no discussion of abstract theory, but all of the examples given and the opinions advanced are based upon results achieved in actual practice, and as such may be considered as having satisfied the test of trial. As was to have been expected, modern methods, practice, and appliances are given a generous allotment of space. The matter on the use of concrete piles is exceptionally good. while it is also recognized that the jetting of piles has become so extensive as to be worthy of an entire chapter in which the details of plant and methods are fully discussed. Metal sheet piling is also treated at length, while the making of foundations by the open dredging process has been described in much detail. Valuable additional data have been added on the bearing power of soils, including Corthell's valuable conclusions. Friction on piles and caissons is fully covered. New matter will be found on piers and wharves, dams, sea-walls, and retaining walls, dry-docks and locks, and also two chapters on the cost of foundation work, in order that the subject of foundations might be so covered that the engineer will not have to go to any other source of information properly to execute such work. In the brief space allotted to reviews, it is impossible to do full justice to the value of this work. A recital of the table of contents could only partly convey an idea as to the wealth of data that is given and the degree of skill that has been shown in its compilation and presentation. There are many technical books published and in many of them there are comparatively little data that are not to be found elsewhere. Mr. Fowler's work, however, is of such a nature as to impose a severe temptation upon the reviewers to indulge in that hackneyed phrase, 'it fills a long felt want.'

THE TRACTIVE RESISTANCE OF A 28-TON ELECTRIC CAR. By Harold H. Dunn. Bulletin No. 74 of the Engineering Experiment Station of the University of Illinois.

This bulletin records the results of tests made with a 28-ton electric car of the double-end type for the purpose of determining the resistance offered to its motion when running on straight level track in still air at uniform speed, and to ascertain the relation existing between that resistance and the speed of the car. The tests were made on sections of straight track representative of good electric railway construction, during generally fair weather when the average temperature was not below 25°F., and when the wind velocity did not exceed 26 miles per hour. The plan of the tests, which involved running the car backward and forward over a selected section of track, made it possible to eliminate wind resistance. The results are finally expressed in the form of a curve whose co-ordinates are car resistance and speed. This curve shows that at 5 miles per hour the car resistance was 5.25 lb. per ton, that at 25 miles per hour it was 13.03 lb. per ton, and that at 45 miles per hour it was 26.12 lb. per ton. The average results from the individual tests did not vary more than 9% from this final curve. Copies of Bulletin No. 74 may be obtained gratis upon application.

PROCEEDINGS OF THE TENTH ANNUAL CONVENTION OF THE AMERICAN ROAD BUILDERS' ASSOCIATION. Published by the Association, 150 Nassau St., New York. P. 320. Price $2.

Everyone at all interested in the good roads movement is more or less familiar with the work and aims of this Association. New and good roads having become a live issue all over the United States within a comparatively short time, engineers have had to familiarize themselves with a new set of conditions brought about by the almost universal use of motor cars and motor trucks. American road engineering practice, if such a thing exists, varies widely in different localities, and it is only by the activities of such an institution as this that order may be brought out of the somewhat chaotic conditions existing at present. The sessions of the Association took place during December 9, 10, 11, and 12, 1913, and were attended by many of the most prominent road engineers in the United States. Papers were read on nearly every possible type of road, and from them many valuable conclusions may be drawn. Of no small interest are the discussions following the reading of the papers, and as they have been printed in full following the text of each article, their value is greatly enhanced thereby. In addition to the technical papers, reports of committees, lists of officers and members, by-laws, and constitution are also given. This Association is doing an excellent work and is worthy of even a greater support than is already accorded to it.

LINK BELT SILENT CHAIN, DATA BOOK No. 125. Link Belt Company, Chicago. P. 112.

Once upon a time, engineers who were called upon to design close coupled mechanical drives had no recourse other than gearing. This was not an especially difficult problem as long as slow moving prime movers were in vogue, but with the advent and consequent almost universal use of the high speed electric motor, it became another story. Plain belt drives were fairly efficient when sufficient distance between centres of pulleys was obtainable to give a good arc of contact. Out in the country where ground space was not a vital consideration, good enough results were obtained mechanically, but at a high cost for maintenance. Transmission of power through a single train of gears was also far from perfect, principally by reason of its rigidity any shifting through settling of foundations or otherwise resulting in a greatly increased friction loss, wear and tear on gear teeth and generally unsatisfactory operation.

With the advent of the silent chain a genuine progressive step has been made. This chain is practically a flexible rack, accurately machine cut, and by reason of this same flexibility has all the good features of the gear and belt or rope drive with none of their disadvantages. Some truly remarkable results have been obtained as far as efficiency is concerned, and in fact it is with difficulty that means can be devised whereby the actual loss in transmission of power by this means can be accurately measured. The Link Belt Company in putting out this, its latest publication, has embodied therein not only the usual data regarding types, standard sizes and prices, but has also included a quantity of information regarding the many applications of its silent chain, methods of using, engineering formulae, and instructions for installing and starting. Dimensions of standard sizes and gear ratios are given in tabulated form for the convenience of designers. As a whole, this is a publication of unusual value and worthy of a place in the library of any engineer interested in the mechanical transmission of power.

It is especially interesting to study the methods by which the links are fastened together, the simplicity and efficiency whereby lost motion is reduced to practically nothing.

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Hints on Practice

THE TESTING OF FANS

The objects of fan testing are, generally to determine: (*a*) the quantity of air per minute passed by the fan; (*b*) the resistance overcome by the fan—namely, the water-gauge; (*c*) the efficiency of the fan; and, in some cases, (*d*) the efficiency of the whole plant.

QUANTITY OF AIR.—The quantity of air passed by a fan is not infrequently calculated from a single anemometer measurement made in the fan chimney or in the fan drift. The more ordinarily accepted method is to divide the area of the chimney or drift into a number of rectangular and approximately equal areas, in each of which a reading is taken by the anemometer. From these readings, after the correction (if any) for the anemometer used has been applied, the average velocity per minute over the whole area is determined. The variation of velocity is not regular, and the velocity in any one of the test areas can hardly be considered uniform over the whole space, or even uniformly variable. This raises the point whether the average velocity as usually determined is correct for areas over which the velocity varies widely. In the opinion of the writer, the most accurate results are obtained when the anemometer is kept continually moving at a uniform rate over the small area being measured, and then moved on to the next area without any stoppage, and so on; the instrument being kept continually on the move for the period during which it is being used in each area. It is assumed that the time for which the anemometer is kept in any space is one minute; but smaller periods will serve if it is necessary to shorten the time occupied in obtaining a complete reading over a fairly large area.

It is important that the anemometer should be calibrated both before and after tests, and that a type of instrument suitable to the velocity being measured should be used. This is especially so in the case of measurements made in the fan chimney, where the velocity is usually high. In whatever way the average velocity per minute of the air has been determined, the product of that velocity and the area in which it was obtained give the quantity of air passed per minute through the fan. This may be more or less than the fan performance, as the natural ventilation of the mine will in some cases assist the fan, and in other cases be against it. The true performance of the fan can therefore be arrived at only after an allowance has been made for the effect (if any) of natural ventilation.

If anemometer measurements are taken in a fan drift, they should be made in a part of the drift sufficiently far from the ear of the fan to be beyond the region of whirling air, and in a straight or nearly straight part of the drift, so as to insure a moderately even distribution of the air over the whole area. On account of the great variation in the length and form of fan drifts, the writer is of opinion that it is preferable to measure the quantity of air in the fan chimney; and the results of measurements made simultaneously in a fan chimney and in a fan drift favorable for accurate measurements show that the quantity of air obtained either way is in very close agreement.

WATER-GAUGE.—Fig. 1 shows several styles of water-gauge tube termination in the fan drift, the most usual form being A. With this form the real water-gauge is not obtained, except when the air velocity is small, as with a high air velocity the current causes a sensible reduction in air pressure in the gauge tube, and a consequent increase in the height of the water column. This may be quite a substantial amount, and may spoil an otherwise carefully made test. B is another form of water-gauge tube termination; C yet another form; and D is, in the writer's opinion, the correct form. It is used entirely to eliminate the velocity factor, and registers exhaustion only. It is rather difficult to make exact measurements of the water-gauge, on account of the oscillation of the water column, and it is therefore advisable to adopt means to eliminate this oscillation. Even if this has been done, two observers often give different measurements of water-gauge, and the effect of a small error in measuring the gauge is important, especially at low water-gauges. When a gauge of type A is used, the water-gauge registered depends to a great extent on the position chosen for the gauge, high measurements being obtained if the gauge is placed where the velocity is small. The result obtained in this way, particularly if the distribution of air is irregular, may be very misleading. If the style of gauge shown at D is used, the result obtained is independent of the position of the gauge, so long as it is placed near the fan, in order to register the whole of the resistance overcome. The water-gauge should be corrected for the effect of natural ventilation.

EFFICIENCY OF FAN.—When the power in the air has been found, the efficiency of the fan is ascertained by dividing the power in the air by the power exerted on the fan shaft. The power exerted on the fan shaft must, in the case of direct engine-driven fans, be measured by a dynamometer, or calculated from the I.H.P. of the engine multiplied by a factor—namely, the efficiency of the engine; or, in the case of direct motor-driven fans, by the efficiency of the motor. In the case of fans driven by belt or ropes, an additional factor is employed, so as to allow for loss of power in the drive. When the drive is by motor, the electrical input should be measured by a watt-meter. Errors can hardly be avoided if both a volt-meter and an ammeter are used. In a very carefully conducted test, should the barometer be taken into account?

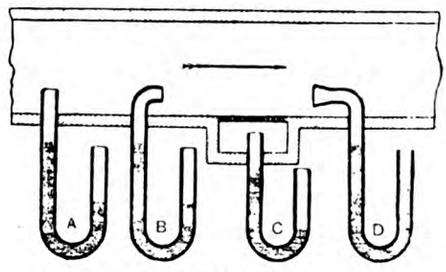

FIG. 1.

The weight of air at 32 in. of mercury is about 14% greater than the weight of the same volume of air at 28 in. of mercury, the temperature being the same in both cases.

GENERAL EFFICIENCY.—The efficiency of the whole plant is, of course, ascertained by dividing the work done on the air per minute by the work of the engine or motor per minute. The degree of exhaustion produced in the interior of the fan can be measured on the water-gauge by completely stopping the entrance of air to the fan drift and running the fan at its speeds as when this is done for testing purposes. The degree of exhaustion due to the velocity of the fan blades can be calculated and reduced to a water-gauge usually called the 'theoretical water-gauge.' The manometric efficiency of the fan is found by dividing the gauge produced in the fan drift, when all entrance of air has been stopped, by the calculated theoretical water-gauge. The writer has not, however, been able to determine what useful object is served by obtaining this ratio.

It is important to make a careful test of the difference between the water-gauge obtained in the closed drift and the water-gauge obtained in the open drift for the same speed of fan. This difference is the measure of the resistance to the passage of the air through the fan, and is well worth knowing.

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In evidence of the divergence of practice in regard to measurement of the air and the water-gauge, the following stipulations are extracted from recent fan specifications, not with the view to criticising the stipulations themselves, but solely for the purpose of exhibiting the differences of opinion existing: (1) The quantity of air and the water-gauge are to be measured in the upcast shaft. (2) The quantity of air and the water-gauge are to be measured at the pit bottom near the separation doors. (3) The quantity of air is to be measured in a fan drift at a place specified, and the water-gauge is to be measured by a tube led into a box in the side of the fan drift covered by a perforated plate. (4) The quantity of air, the speeds, the horse-power in the air, and the brake horse-power at the fan pulley, with varying water-gauges of 3 in., 4 in., 5 in., and 6 in. at constant equivalent orifice, must be stated.

When conditions differing so much are laid down, and where such differences in actual practice in testing as have been referred to are possible, one need hardly wonder that the results of tests are not readily comparable. The writer submits, therefore, that the whole subject of fan testing requires careful consideration, in order that conditions universally applicable may be devised, so that the results of tests which may be carried out under these conditions should be readily comparable.—*Mechanical World.*

Company Reports

California Natural Gas Co., of Richmond reports for 1913 as follows:

ASSETS

Fixed capital	$357,765.14
Cash	204,636.02
Accounts receivable	34,650.27
Investments	100.00
Other assets	52,234.08
Total	$649,385.51

LIABILITIES

Capital stock	$350,000.00
Accounts payable	17,597.46
Reserves	21,638.92
Other liabilities	27,924.54
Surplus	232,224.59
Total	$649,385.51

PROFIT AND LOSS

Operating revenue	$411,885.46
Operating expenses	308,723.22
Net operating revenue	$103,162.24
Non-operating revenue	5,396.51
	$108,558.75
Balance December 31, 1912	123,665.84
	$232,224.59

Coalinga, Fresno county, has asked the California Railroad Commission to abrogate a contract between the Pleasant Valley Water Company and the Coalinga Consolidated Water Company, whereby the latter furnishes all the water distributed by the former for one-half the gross receipts. The petition also asks that the Coalinga Consolidated Water Company be compelled to furnish the Pleasant Valley Company with hard water at ½c. a barrel and distilled water at 3½c. a barrel, and also that the Pleasant Valley Company be directed to reduce its rates.

Union Water Co. of Oakland reports for 1913 as follows:

ASSETS

Fixed capital	$9,902,627.24
Cash	1,789.92
Accounts receivable	281,373.45
Investments	377,166.85
Discount on stocks and bonds	106,293.60
Other assets	10,362.93
Deficit	162,372.24
Total	$10,841,986.23

LIABILITIES

Capital stock	$5,000,000.00
Funded debt	5,071,164.94
Accounts payable	299,913.54
Reserves	3,000.00
Other liabilities	467,907.75
Total	$10,841,986.23

PROFIT AND LOSS

Operating revenue	$ 35,424.86
Operating expenses	37,644.27
Net operating deficit	$ 2,219.41
Non-operating revenue	17,450.00
	$ 15,230.59
Taxes, interest, etc.	72,794.00
	$ 57,563.41
Deficit December 31, 1912	99,915.90
	$157,479.31
Additions	730.75
	$156,748.56
Other deductions	5,623.68
Deficit	$162,372.24

Plunket Canal Co. of Bakersfield reports for 1913 as follows:

ASSETS

Fixed capital	$ 5,000.00
Accounts receivable	2,613.27
Discount on stocks and bonds	40,225.00
Other assets	4,775.00
Total	$52,613.27

LIABILITIES

Capital stock	$50,000.00
Surplus	2,613.27
Total	$52,613.27

PROFIT AND LOSS

Operating revenue	$ 1,307.43
Operating expenses	110.45
Net operating revenue	$ 1,196.98
Balance December 31, 1912	1,416.29
Balance	$ 2,613.27

Authority to issue capital stock of the par value of $19,200 has been granted by the California Railroad Commission to the Ojai Power Company, operating an electric light, power, water and distributing system in and about Nordhoff, in the Ojai valley, Ventura county. The money realized from the sale of the stock will be expended on the purchase of additional electrical equipment.

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Construction News Summary

Condensed From Our Daily Construction News Service.

CALIFORNIA

ALAMEDA—Mayor has appointed Wm. Hammond, Jr., Frank C. Bartlett, and C. W. MacRae as committee to report on type pavement to be installed and for which bond issue is to be called.

ALHAMBRA—Board of Trustees has accepted plans for East Main street project.

ANDERSON—Plans have been prepared for construction of an irrigation system for the C. C. Moore ranch. A. J. Shields is manager. Halcombe & Flanders, Phelan Bdg., San Francisco, consulting engineers.

AUBURN—Contract for grading Dairy Farm railroad from Sheridan to Vantrent has been let to Alta Construction Co. Length 8 miles, price $14,000. E. B. Braden, pres., C. C. Corbett, secy., Merchants Ex. Bdg, San Francisco.——Plans for reinforced concrete grammar school are completed. W. H. Weeks, San Francisco, architect. Cost $45,000.

BAKERSFIELD—City Council has ordered paving of alleys in blocks 243-5-6-7 and 8. Oiling N street from 20th to 25th and grading has also been ordered. Plans for improvement of Cedar street between 18th and 24th have been approved.——Board of Trustees will call for bids for paving Chester avenue. Mr. Greely, city engineer.——Union Oil Co. has placed contract with Mahoney Bros. and Allison & Cole for the construction of a 1,000,000 barrel reservoir at tank farm near San Luis Obispo. Cost $35,425.——City Engineer Greely has prepared plans for a sewer district in East Bakersfield.

BENICIA—City trustees will call bond election to provide funds for constructing 1 mile of pavement to connect city streets with State Highway at Benicia Barracks. Resolution of intention has been passed to construct sewers at eastern end of the city.

BERKELEY—City Council has called for a bond election, Sept. 12, providing $1,175,000 for schools, water front improvements, and civic centre.——City Council has ordered Oakland Traction Co. to pave Grove street. Resolution of intention has been passed to open Walnut street from Berkeley way to University avenue, cost $85,000.

BIGGS—Plans are under way to pave B street from 1st to 2nd streets.

CHICO—Associated Oil Co. will build distributing depot at this point. Estimated cost $12,000.——U. S. Treasury Department has awarded contract for construction of post office to B. J. Duffy of Davis, Cal. for $76,980.——The asphaltum mixing plant owned by the Chico Construction Co. has been destroyed by fire. Loss $10,000.

CUCAMONGA—Cucamonga storm water protection district will reconstruct ditch from San Bernardino avenue to intake. Estimated cost $5000. Plans and specifications are under way. J. H. Klusman, president; J. H. Rupp, vice-president; and C. E. Hirschler, secretary.

DINUBA—Ransome Crummey Co. of Oakland has failed to enter into contract for street paving. Deposit of $1594 was made. City Council will readvertise bids. Twelve city blocks are to be paved.——Bond issue for new primary school has been defeated.——City Council is considering the installation of a 10-box fire alarm system.

DOS PALOS—Plans for construction of 80 miles of highway have been endorsed by joint committee from Dos Palos and Los Banos. Bond issue of $400,000 is to be voted.

ESCONDIDO—The Volcan Water Co., Edward Fletcher, manager, has made first payment for Carroll damsite in Crescent valley. This is part of project under which water supply is to be sold to the city of San Diego.

ESPARTO—Plans are completed for bridge across Cache creek. Cost $35,000. Mr. Ashley county surveyor, Woodland, California.

EXETER—Plans have been adopted for Carnegie Library, cost $5000. Mr. McEvers city clerk.

FALL RIVER MILLS—John R. Creighton, J. A. Rogers, and others of this district are contemplating the construction of a pumping plant for this district. A bond issue is under way for $15,000.——An irrigation district has been formed, known as the West Side Irrigation District. Pumping plant, reservoir, and ditches will be installed.

FRESNO—Bids will soon be called by the Board of Education for a new grammar school to be built in the Tipton district. Ernest J. Kemp is architect. Estimate $18,000.——Stinson-Burrel Reclamation district will expend $210,000 for construction work. Mr. Teilman is engineer, J. E. Lewis, H. L. Ward, and Frank Allison are directors.——A permit has been granted to R. F. Felchrin for constructing packing plant for Roeding Fig & Olive Co.——Fresno Consumers Ice Co. will add $250,000 to its capital stock for enlarging its plant. Calvin S. Hill is general manager.

GALT—Project for construction of new sewer system is under discussion. Estimated cost $17,000.

GLENDALE—Bond issue for acquiring municipal water works system has been approved.

GRASS VALLEY—City trustees will call for bids for sewer improvements for Whiting, Leduc, and Pine streets.

HANFORD—County Highway Commissioners have reported to Board of Supervisors recommending bond issue of $675,000 to construct 73½ miles of road.

HERMOSA BEACH—City trustees have ordered improvement of a section of El Camino Real, cost $50,000. Cement sidewalks will be laid.

KERMAN—Proposed bond issue of $40,000 for Union High school has been defeated.

KINGSBURG—City trustees have passed resolution of intention to pave 8 city streets. All will be graded, oiled, and macadamized. Cement curbing and sidewalks.

LA MOINE—F. Rolandi of San Francisco has sublet grading construction on La Moine Sims Unit of State Highway to E. R. Burtis and Chas. Wagner of Redding.

LINCOLN—City trustees will advertise for bids for an addition to present high school building.

LINDSAY—Board of Education will soon call for bids for new school. Bonds have been sold. Estimate $50,000.

LONG BEACH—Board of Public Works will soon be in the market for 2000 tons of cast iron pipe and 20 tons of screw pipe. City will construct a sewer system at cost of $340,000. H. B. Riley, city clerk.

LOS ANGELES—City Council has adopted ordinance for improvement of a section of 16th street. Ordinance of intention to open and extend 16th street has been adopted. Park Commission will construct tennis courts at Eastlake Park.——Board of Public Works will readvertise bids for sewer in Monita avenue.——City has sold bonds for improvement of Sunset Boulevard. Work will commence at once. Amount $96,848.05.——Harbor Commission will advertise for bids for dry dock. Clarence Matson, secretary.——Public Works Committee of City Council will call for bids for 60-ft. roadway in Western avenue from Fountain avenue to Temple street.——Montecito Railroad Co. of Los Angeles has asked permission to sell 50,000 shares of stock at 90c. to construct electric railway in Los Angeles.——Harbor Commission has instructed engineering department to prepare plans for widening Mormon Island channel.——City Council has approved assessment for improvement of Mission road from Gallardo to Baldwin street. City engineer has recommended that Western avenue from Fountain to Temple streets be improved at once. Improvement of 7th street to connect Wilmington with Anaheim road at Long Beach is contemplated.——Board of Public Works has awarded contract to T. J. Shea for Alameda street storm drain and improvement of street from No. Main to Sixth street. Price $187,665.11.——Association has been formed to undertake construction of concrete base highway from business district to water front. Address Harbor Truck Highway Assn., City Hall, Wilmington. D. R. Woods, president; W. R. Peder, first vice-president.; W. H. Turner, second vice-president; Henry Carter, secretary; E. H. Eubanks, treasurer.——Atchison, Topeka & Santa Fe railway has completed plans for constructing 50,000,000-gal. reservoir and pipe-lines near Flagstaff, Arizona. Estimated cost $200,000.——California Portland Cement Co. with works at Colton, has purchased for $116,831 135 acres of orange land adjoining its plant to stop litigation for damages. Announcement has been made by T. J. Fleming, general manager, that size and capacity of plant will be doubled.——Plans for Arroyo de la Sacatella storm sewer system have been approved by City Council. Estimated cost $99,579. Union Oil Co. has selected site and will build oil refinery.

MADERA—City Council will call a bond election in September to provide improvements to fire protection system, water and sewers, city hall and a bridge, total $100,000.

MARYSVILLE—State Engineering Department will deepen channel of Feather river. P. N. Narboe, state engineer, Sacramento.

MERCED—Associated Oil Co. has purchased site and will install four oil storage tanks and warehouse. L. D. Jurs, engineer, Sharon Bdg., San Francisco.——Bids will be received to 10 a. m. August 28 for bridge across Merced river in Road District No. 3. P. J. Thornton, clerk.——A project is under way for the construction of a new theatre. Estimated cost $26,000. C. H. Douglas is interested.——A bond issue for a

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municipal water system to replace that of the Crocker Huffman Land & Water Co. is projected. T. W. Fowler, chairman; G. W. Atwood and E. R. Albord, water committee.

MODESTO—Modesto Irrigation district will advertise $610,000 bonds for sale to provide funds for various improvements. R. A. Edwards is engineer for district. Thomas Berry, of Berry & Winterhalter, San Francisco, has been retained as consulting engineer. Reservoir dam will be built.——T. K. Beard Construction Co., has been awarded contract for constructing levee on Kings river for Stinson-Burrell Reclamation district, estimated cost $46,000; for building diverting dam in Tuolumne river near Chinese, estimated cost $6000.——Contract for skew beam bridge near La Grange, reinforced concrete bridge over Dunn creek and another near Cooperstown, and for a culvert near Waterford has been awarded to J. D. Nimon & Son. Price $5570. Plans and specifications for bridge over Tuolumne river near Waterford have been accepted. Bids will be received to 11 a. m., August 10.——Plans and specifications for bridge across Tuolumne river between Waterford and Hickman have been accepted. Estimated cost $29,000. E. H. Annear, county surveyor.——City Council has ordered paving of 9th street from Lateral No. 4 of Modesto Irrigation District north to city limits, surface to be 15 ft. wide. Bids will be called on same type pavement as used for State Highway and for asphaltic concrete as an alternative. Mr. Thompson is city clerk.

MOJAVE—Special election will be held on August 8 to form a lighting district.

MONTAGUE—Bond issue has been voted providing $12,000 for new school.

NAPA—Napa City Water Co. is authorized to issue $30,000 bonds ($10,000 for extending company's system to Alta Heights).——Bond issues of $10,000 storm sewers and $12,000 for motor fire truck have been approved.——Bids for $25,000 bridge bonds have been rejected by the city trustees.

OJAI VALLEY—Ojai Power Co. will expend $19,000 for improvements, electrical equipment, extensions, and buildings.

OAKLAND—City proposes to construct bascule bridges across the estuary. Perry F. Brown is city engineer.——Board of Supervisors will alter county road from Niles to Warm Springs.——Council has ordered city engineer to prepare plans for opening 12th avenue and extending it to bulkhead line.——City Council has adopted plans and specifications for improving portions of Weld street. A. Lazzareschi will construct sewer, curbs, gutters, and sidewalks on the west side of High street.——Bids have been called to 10 a. m., August 10, for improvement of Niles Canyon Road No. 4974. John P. Cook, clerk.——County surveyor has been directed to prepare plans and specifications for sprinkling plants in Castro valley and for trestle bridges on county road between Alvarado and Centerville. Repairs are to be made on Fruitvale avenue bridge.

OROVILLE—Board of Supervisors has decided to construct two additional bridges, one over south Honcut river 140 ft. long, made of reinforced concrete. Plans will be drawn by M. C. Polk, county surveyor. Second bridge will be built over Honcut creek on the Oroville Marysville road and made of reinforced concrete 16 ft. long.——Plans and specifications have been adopted for two bridges, one reinforced concrete 40 ft. long over Chico creek; one steel structure on concrete piles over Angel slough 260 ft. long. Bids will be advertised.——Petition has been presented to supervisors for formation of Road District No. 16. Bids for construction of North Honcut bridge were opened as follows: O. A. Peter $823.81, extra reinforced concrete $17.50 per cu. yd.; Jenkins & Wells, $1092; Jenken & Holmes, $1349.40; extra reinforced concrete $20 per cubic yard.

PASADENA—Municipal light department is to install generating unit. General Manager Koiner.——City commissioners are considering calling for bond issue for improvements to city water and fire departments. Approximate cost $160,000.

PLACERVILLE—Board of Supervisors has retained Clifford B. Rushmer to prepare plans for retaining wall 40 ft. wide to be built on Webber creek.——Plans and specifications for Bucks bar bridge across north fork of Cosumnes river prepared by C. H. Wildman, have been accepted and contract awarded to J. R. Nelson, Walter Vertrees, and D. M. Stevenson.

PORTERVILLE—Preliminary estimates and plans for permanent protection work on Upper Tule river have been submitted. I. H. Aulthorn city engineer. Byron O. Lovelace, county surveyor. Estimated cost $15,000 to $17,000.——County Commission consisting of N. M. Ball of Porterville, J. F. Gibson of Visalia, and W. P. Boone of Dinuba, has announced unofficially a decision that concrete base with thin oil macadam or asphalt macadam surface is best adapted to Tulare highway conditions and will be used on proposed system of county highways.——Residents of Deer Creek district have petitioned Board of Supervisors to construct new bridge over Deer creek at cost of $2000.——A petition for the extension of Lafayette street has been presented to City Council.——J. L. Roberts, architect, is promoting a project for the construction of a modern theatre building.

RED BLUFF—Tehama county Board of Supervisors will call bond election providing $170,000 for bridges. Ten bridges in all are to be built.——Plans for construction of inter county road from Paskenta to Round Valley have been approved by Supervisors. Estimated cost $5000.——Board of Supervisors will call an election August 25 to authorize bond issue of $200,000 to construct roads and bridges.

REDDING—Cottonwood Irrigation District has been organized. Directors McCoy Fitzgerald, W. C. Barkuloo, A. J. Shields, A. W. Smith, W. H. Logan.——Will call for bond election to provide funds for various improvements. Estimated cost $350,000.

REDONDO BEACH—City Council is considering acquisition of a municipal water system.

RICHMOND—Warren McBryde, county supervisor, is preparing plans and specifications for concrete bridges along state highway between Martinez and Richmond. Bridges will be built by Contra Costa Board of Supervisors.——Hyde Harjes & Co. of San Francisco have received contract from Standard Oil Co. for construction of wharf and float for Martinez supply plant.——Bond election to provide $2,500,000 for municipal water supply has failed of approval. Plans are being made to call for another vote.——Contract for paving 9th street was awarded to G. W. Cushing Co. Price $3.50 per front foot.——Bids for dredging harbor channel were open. Western Reclamation Co., $4975; H. C. Cutting Co., $6000.——Bid of Frank Aguar for paving Montecido and Golden Gate avenue at $8.80 per front foot rejected. Bids will be re-advertised. Plans and specifications for dredging Inner Harbor from Pt. Orient to Ellis Channel have been adopted; 70,000 cu. yd. of dirt to be removed, estimated cost $6000. Mr. Posey is engineer.——City Council has adopted plans and specifications for paving 23rd street.

RIVERBANK—Riverbank Water Co., R. W. Hobart, president, will extend its system at Riverbank and reconstruct system at Hughson, California.

SACRAMENTO—Board of Trustees, Junction School district, has called for bids to August 10, for repairs to school building. Address H. Hebard, 1735 Redding avenue, Sacramento.——City Commission will build 26-in. concrete pipe sewer in Schley avenue.——The High School Board of Education has called for bids for lighting fixtures for Manual Arts building of Sacramento High School to 10:30 a. m., August 17. C. E. C. Hemmings, architect, 1203 J street.——Contract for Yolo basin trestle from Sacramento to Davis was awarded to Graff Construction Co. of Seattle. Price $239,703.80. Engineer's estimate $248,385.63. Contract was awarded to Palmer & McBryde Construction Co. of San Francisco for section of State Highway in Shasta county between Bayha and the Sacramento river. Price $166,216.40. Engineer's estimate $170,526.03. Bids will be readvertised to be open August 24 for sections of State Highway in San Bernardino county 6.5 miles, San Benito county 4 miles, Kern county 17.3 miles, San Diego county 1.6 miles. Bids will be called probably August 31, for 82.3 miles of State Highway in Colusa, Sacramento, Solano, San Bernardino, Kern, San Luis Obispo, Orange, and Los Angeles counties. City Commission has opened bids for street work on California street from Ransome, Crummey Co., McGilvray Construction Co., and Clark & Henery Construction Co. Estimated cost $65,000. Boards of Supervisors of Solano and Sacramento counties have accepted plans for proposed bridge across Sacramento river at Rio Vista. Plans and specifications of the Strauss Bascule Bridge Co. of Chicago have been accepted for the Walnut Grove bridge across Sacramento river; bids will be called for August 20, 2 p. m.——State Reclamation Board has approved plans for bascule bridge at Walnut Grove. Modifications in plans for Long bridge over Butte Slough have been approved. Advisory Board state engineering department will expend $34,700 for new levees on San Joaquin river near Stockton.——Plans for construction by the county, of 271.55 miles of roads and 64 bridges, submitted to Board of Supervisors by H. C. Maginn, secretary Sacramento County Highway Commission. Estimated cost $2,425,000. 45.67 miles of cement concrete base, asphaltic surface; 25.57 miles water-bound macadam, asphaltic surface; 43.12 miles of gravel. All bridges will be reinforced concrete.——Specifications have been completed for extension of East Sacramento water mains on J street from 31st to Montclair avenue.——City Commissioners will have plans prepared for connection with water supply at foot of I street. New intake cost $45,000 and caisson cost $15,000 will be built.——The city has placed contract with Power Equipment Co. of San Francisco for city sewage pumping plant. Price $38,400.——The Northern Railway Co. will expend $50,000 for reballasting and replacing wooden culverts with concrete. Mr. McGovern, general manager. Application

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of Louis Titus for new Pescadero Reclamation at Paradise Cut, San Joaquin county, before State Reclamation Board has been withdrawn. The following contracts have been let for sections of State Highway: Yolo county 11.7 miles, M. Blumencranz of Stockton, $53,988.60; Santa Cruz, 10.3 miles, Occidental Construction Co., Los Angeles, $54,761.50; San Luis Obispo, 13.4 miles, Rogers Bros., Los Angeles, $86,986; Ventura 11.1 miles, Leigh G. Garnsey, Los Angeles, $96,121.25.——Permit for new building for sewage pumping station has been issued to Teichert & Ambrose, contractors. Cost $49,480.——State Highway Commission will ask an appropriation for connecting links between San Joaquin valley and Coast Highway. Surveys have been ordered.

SAN BERNARDINO—Contract for paving 7th street has been awarded to Highway Construction Co. for $17,008.18; 9th street, $15,361.13; G street, $4,147.94.——Board of Education has adopted plans and specifications for high school buildings. Estimated cost $250,000. Norman F. Marsh, architect. Bids are called.——The Water Commission, Superintendent Harris, is considering construction of filter to purify Lytle creek water. The Fontana Land Co. has organized, with a capitalization of $2,500,000. It will engage in agricultural and land business at Fontana. Directors A. B. Miller, V. J. Micallef.

SAN DIEGO—City Council has been petitioned for franchise by Bay Shore railroad. C. W. Fox, president. A line is to be built from ocean to Pacific beach. Bridge over channel in Mission bay is proposed. George Butler, county supervisor, is preparing plans for bridges to be built under proposed county bond issue.——Edwin Duryea, Jr., consulting engineer, Humboldt Bank Bdg., San Francisco, has approved plans for improvements to water system; cost $705,000.——San Diego & Arizona Railway Co. has asked permission to expend $219,956 for construction materials.

SAN JOSE—County Board of Supervisors has called for bids to 11 a. m., August 17, for construction of a concrete rubble wall on Candle creek, and for reinforced concrete culvert on Hardwood road. Henry A. Pfister, clerk.——Ground was broken July 19 for new Big Basin Highway; cost $470,000. Concrete base and bituminous surface will be used.——J. G. McMillan, county surveyor, has prepared plans for handling flood waters from Canoas creek, with recommendation for the enlargement of the present conduit by substituting reinforced concrete for the present brick structure.

SAN FRANCISCO—Board of Public Works will order improvement of section of Berry street. Bulkhead to be constructed. Estimated cost $30,000. Sewer construction is to be undertaken as follows: Glen Park, $20,000; Fifth street, $65,000; Fulton, $20,000.——John McLaren, superintendent Golden Gate Park, will call for bids for paving park panhandle with vitrified brick. Board of Supervisors will have plans completed in a few days for boulevard to connect Presidio and Exposition grounds with Lincoln park. Estimated cost $50,000. Cost of construction to be borne by Exposition company.——Board of Works is preparing plans for improvement of Sloat boulevard. Estimated cost $50,000. Finance committee Board of Supervisors will call for bids for construction of Bakers' Beach outlet sewer, Glen Park extension sewer, and 5th street sewer. Estimated cost $130,000.——Consideration of plans for construction of Church street line of municipal railway has been postponed until first week in September.——Valley Pipe Line Co. has asked permission to issue $5,318,400 of common stock at $80 per share, to provide funds for pipe-line 174 miles long between Coalinga and Martinez. Contracts for pipe and boilers have all been let. Contract for pumps pending.——Northern California Power Co. will increase capital stock by $2,000,000.——Board of Supervisors have appropriated $42,000 for completion of new jail building; $4000 for paving portion of Lincoln Way.——Board of Public Works has called for bids until 2 p. m., August 19, for Twin Peaks tunnel construction; 12,000 ft. long, 25 ft. wide, 15 ft. high. Estimated cost $4,000,000. Bond required $500,000. Certified check for 10% of bid to accompany proposal. Printed forms on application to M. M. O'Shaughnessy, city engineer.——State Railroad Commission has authorized Round Valley Water Co. of Greenville, Cal., to lease its property to Plumas Light & Power Co., formerly known as Indian Valley Municipal Light & Power Co.——Board of Works has awarded contract for municipal railway carbarn to Daniel O'Day Co., price $34,850; contract for furring and lathing Academy Building, Polytechnic High School, to Holloway Expanded Lath Co., for $19,492; contract for improving and adorning plaza in civic centre has been awarded to T. W. McClenahan & Co., price $54,860; contract for municipal asphalt plant awarded to Rogers Davis Co., for $31,795.——Board of Supervisors has made appropriations for public improvements as follows: Additional pile foundations, Municipal Asphalt Plant buildings in Corporation Yard, $2500; repairs to 3rd street bridge, $6149; reduction of sidewalks, Stockton street, between Geary and Post, $1350; improvement of island parks in Dolores street from 18th to 20th streets, $1500; completion of Polytechnic High School, $165,000; repairs and improvements Isolation Hospital, $5000; Machinery Municipal Asphalt Plant, $20,000; paving brick for 3rd street, $11,820; paving 17th street, Bryant to Hampshire streets, city's portion, $3000; shop buildings for repair departments, Board of Public Works, $20,000; reconstruction of 4th street bridge, $50,000.——E. B. Bumstead, Insurance Bdg., will build a 20-mile transmission line and power plant for the California Power & Development Co.——Fresno Interurban Railway has been authorized to issue 600 shares of stock and $120,000 in bonds. Money is to be expended for extension of company's lines from Clovis, Fresno county. Contract for constructing road from Hog Ranch to Hetch-Hetchy damsite was awarded to Utah Construction Co. for $151,499.50. Contract will be awarded to Larsen Samson Co. for interior station for new City Hall, price $187,500. Mission Marble Works has been awarded contract for bases, streets, and space for $26,033.

SANTA BARBARA—Bonds for $120,000 recently authorized, have been offered for sale to provide funds for completion of Mission tunnel and dam. Bids for constructing new seawall will be called for August 6.——Geo. P. Robinson, city engineer, has submitted plans and specifications on new seawall. Supervisors will pave 20-ft. strip 1 mile long on Broadway. Bids will be opened August 24; cost $15,000.——City of Santa Maria will spend $45,000 for continuing this strip to their city.——Reinforced concrete arch viaduct 80 ft. high, 525 ft. long is to be built at Arroyo Honda. State will pay part of cost. H. J. Doulton, chairman Board of Supervisors.——Contract has been awarded to A. J. Avery for a private theatre for William Miller Graham. Cost $19,430. Contract has been awarded for Grand Stand and Club House for the Santa Barbara Polo Club to J. C. Miller for $12,500.——Plans for reinforced concrete and steel bridge across San Roqui creek on Hollister avenue have been submitted. Estimated cost $7500. Mr. Flournoy, county surveyor.——City engineer has been instructed to prepare plans for main sewer in Modoc Road from Mission street to city limits. Contract has been let to G. S. Bliss of Carpinteria for reinforced concrete bridge over Carpinteria creek for $10,800. Contract has been let to E. F. Edwards for Maria Ygnacio creek bridge at foot of San Marcos Pass road for $3490. County surveyor has been instructed to establish road over top of Nojoqui hill through the Alisal to Santa Ynez Mission bridge.——Right of way for State Road between Goleta and Gaviota has been settled. Highway from Alisal is to be improved. County has been petitioned to join city in building bridge from Mission Creek on Thompson Road.——City engineer has submitted plans for improvement of West boulevard bulkhead. Estimated cost $72,000.

SANTA CRUZ——City Council has let contract to L. T. McFadden for Seabright sewer outlet. Price $2645.——Changes and alterations to the Water street bridge are under consideration by the City Council. Estimated cost $20,000.——Board of Supervisors has awarded contract for bridge over Majors creek to Kauffman Construction Co. of Oakland for $5493. Bridge will be timber trestle structure.

SANTA MONICA—Bond election will be held to provide $150,000 for auditorium. Two sites have been donated.

SANTA ROSA—Specifications have been adopted for asphalt pavements on Santa Rosa avenue from Main street bridge to city limits; for concrete gutters and curbs on Healdsburg avenue. Plans are being prepared for concrete curbs and gutters on 4th street.——Alfred D. Rowen has applied to city trustees of Healdsburg for franchise for 12-mile electric railroad from Healdsburg through Dry creek valley.——Bond issue for the Sebastopol School District, providing $20,000 for new grammar school has been approved.——Board of Supervisors has opened bids for bridges across Franz creek and Gualala river. Lowest bids were submitted by W. L. Proctor, $3739.70 for the former and $18,732.80 for the latter.

SONORA—Bids have been called until September 7, by the Board of Supervisors, for concrete bridge over Sullivan creek. E. E. Newell, county surveyor. Cost $6000.

STOCKTON—City commission has ordered plans for two new fire engine houses. Plans and specifications for improving French Camp at end of Center street have been adopted. Bids are called. Estimate $3803.35. Proposed bond issue for improving city streets was defeated.

SUNNYVALE—Contract has been awarded V. E. Parish, of Cupertino, for constructing new grammar school. Price $15,680.——City engineer Nikerk has recommended extending sewer system, including 6-in. main on Francis street, 8-in. on Washington street, and 6-in. on Charles and Florence streets.

TULARE—City council has deferred opening bids for street paving until meeting of August 3. Sloan & Robson are city engineers. State Reclamation Board is considering construction of levees along banks of San Joaquin river near Stockton.

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——Tulare County Power Co. is contemplating construction of hydro-electric plant near Porterville on Tule river.

TURLOCK—The Turlock Irrigation District will build canals and make repairs to extent of $50,000.——City Council will ask for bond issue to establish a civic centre.

VISALIA—Reinforced concrete substructure and steel superstructure bridge is to be built over Kings river in Dinuba district. Estimated cost $27,500.

WILLOWS—Board of Supervisors have let following bridge contracts; Stony Creek, Ross Construction Co., $2985; bridge on San Jacinto road, Jenkins & Wells, $1235; Hermas Page bridge on Willows Glenn road, W. N. Concannon & Co., $1144; Beck bridge, F. F. Moore, $745; Hulen bridge, Ross Construction Company.

UPLAND—Bond issue is proposed to provide $40,000 for new city hall, streets and highways, and fire apparatus.

WATTS—City proposes to install new sewer system. E. B. Kyle, city engineer.

WOODLAND—Supervisors have ordered reconstruction of bridge near Elkhorn. P. N. Ashley, county surveyor.

YREKA—Contract has been awarded to Clark & Henery Co., of Stockton for paving Main street.

YUBA CITY—Election for a bond issue of $500,000 will be called in November to provide funds for new bridges and a road between Yuba City and a point near Nicolaus. Contract for construction of bridge over Butte slough has been awarded to Blake Bros. of Oakland. Price $68,800. Bridge will be reinforced concrete structure 1920 ft. long in spans of 40 ft.—— County Supervisors have rejected all bids on a proposed bridge from Butte slough. New bids will be called.

OREGON

ASHLAND—New water works are to be built at cost of $175,000.

AMITY—Franchise has been granted to J. W. Morris of Portland for water works. Cost $15,000. Fire hydrants will be installed.

BAKER CITY—Bids have been called for constructing two concrete abutments to August 4, 1 p.m. Address James Cunning, city clerk.——Two pipe-lines are to be added to city fire system by day labor. Estimated cost $98,000.

BEND—Bend Water, Light & Power Co., Mr. Foley, manager, will build a reinforced concrete reservoir.

CARLTON—City Council will soon call for bids for street paving, $50,000 will be expended.

DRAIN—City Council will contract with Douglas County Light & Power Co. of Roseburg for installing an electric lighting system.

EUGENE—The Governor and State Highway officials have approved plans for completion of the MacKenzie river highway. City will install ornamental lighting system at cost of $6000. ——C. A. Elkins and Frank Shelley were awarded contract to erect and install hydro-electric plant near Mapleton.

HERMISTON—Western Land & Navigation Co. will build irrigation reservoir to impound 10,000 acre-feet.

HOOD RIVER—Bond issue of $75,000 for completion of Columbia River highway has been approved.

LINTON—C. W. Woodruff has submitted plans for 6000 lin. ft. of macadam road.

KLAMATH FALLS—O. H. Harris has received contract for 11th street improvements. Cost $17,728.50.——Project is underway for formation of Willow Valley Irrigation project. W. A. Duncan, D. M. Donnelly, R. F. Tuttle, and others are interested. The county court is considering their application.

MAPLETON—R. H. Clow will install city lighting system and build hydro-electric plant near this city.

MEDFORD—City Council will order construction of sewer in Dakota street.——Bids will be called for constructing central point section of Pacific highway. Mr. Bowlby is state engineer.

NEHALEN—$12,500 bond issue to purchase water plants or construct reservoir and electric light plant has been approved.

PENDLETON—City Council is preparing plans for municipal natatorium made of concrete 50 by 100 ft. Estimated cost $6000. ——Contract for paving Matlock street has been let to Warren Construction Company.

PORTLAND—County Commissioners have called for bids for $625,000 inter-state bridge bonds to provide funds for interstate bridge between Multonomah county, Oregon, and Clark county, Washington.——City water engineer Clark recommends extension of 30-in. water main at a cost of $113,000.——City commission has tentatively approved proposed franchise to Portland & Oregon City Railway Co., for interurban line from Oregon City to Portland.——City bridges from Sullivan gulch on Grant avenue and on Union avenue are to be repaired. Cost about $20,000.——Dam is to be constructed at Bull Run Head Works to create reservoir. Estimated cost $80,000.——Bids will be advertised for new roads from city limit to Troutdale. Warrenite 16 ft. wide with 2-ft. shoulders will be used. Estimated cost $133,562.——Bids for interstate bridge across Columbia river will be advertised as soon as bonds have been sold. Waddell & Harrington, Kansas City, engineers. W. L. Lightner, county commissioner.——City Engineering Department completed plans for proposed Holgate street viaduct over Southern Pacific tracks. Estimated cost $56,000. Bids are asked for machinery and valves for Lake Washington canal locks, until noon, August 10. Address U. S. Engineer's office, Burke Bdg. Seattle, Washington.——Dock Commission has ordered municipal dock No. 1 to be changed from slip to open dock. Slip will be dredged; retaining wall will be built. A. C. U. Berry has contract at cost of $120,616. Bids will be called for fender pile system on north line of slip. Estimated cost $21,500.—— J. H. Cunningham will install electric light plant at Ridgefield, Washington.

SALEM—Oregon & Western Colonization Co. has sold to F. W. Waters, Yeon Bdg., Portland, 19,000-acre tract in eastern Oregon. Colonization scheme, including development of water for irrigation and power, is to be undertaken.——Bridge is contemplated over Willamette river. H. L. Bowlby, state highway engineer.——Application of George W. Holcomb for permit to appropriate 1500 sec. ft. on the Clackamas river for developing 10,000 hp. has been approved by John H. Lewis, state engineer. A dam is to be built. Permits have been approved for the Portland Highway Light & Power Co. for two reservoirs, one requiring a dam 30 ft. high and the other a dam 80 ft. high. Both to be built on sites on the Clackamas river.

SPRINGFIELD—Southern Pacific Co. will spend $150,000 for re-ballasting roadbed from Portland to Junction City. D. W. Campbell, assistant general manager.

ST. HELENS—Plans have been completed by the Highway Commission for location of section of road for Columbia Highway from Columbia City to Warren.

WASHINGTON

SEATTLE—$100,000 has been appropriated for construction of steel penstocks from Cedar River dam to power plant. Water mains are to be built in Rainier avenue, cost $24,000; 47th avenue, cost $10,000.——City Council has requested immediate construction of south piers for proposed bridge at Montlake avenue over Lake Washington canal; $30,000 is available. Resolutions providing for grading and curbing Rainier avenue and other streets costing $85,000; planking 26th avenue, cost $8900; sewers in Dearborn street, and grading 1st avenue., N. W., have been approved.——City Council has called for bids for bridge bonds, amount $829,500 for construction of Ballard & Fremont bridges and for $950,000 bonds for construction of Cedar river dam, auxiliary steam plant and Firland hospital. Bids will be opened on September 5. Estimated cost Cedar river dam, $400,000; auxiliary steam-plant, $425,000; Firland hospital, $125,000. ——City Engineering Department has completed plans for two steel and concrete piers for base of trunnion bascule bridge over Lake Washington canal. Estimated cost $30,000.——Contract for constructing 27 miles of Cascade scenic highway has been let to Bruce, Nettleton & Eschbaugh. Price $141,170.——Contract for King county court house has been let to Puget Sound Bridge & Dredging Co. Cost $810,563.——Metropolitan Building Co. has let contract to Grant Smith & Co. for the Stewart building. Price $500,000.——Monroe Water Co. has purchased the property of the Monroe Water & Light Co. Officers are: Sydney Marshall, president and manager; M. E. Barnham, vice-president. Hugh A. Goodfellow, secretary and treasurer.—— Puget Sound Light & Power Co. is considering construction of street railway on Ravenna boulevard. E. C. Gaumnits is purchasing agent.——Bids will be opened July 8 for improvements on Salmon bay, by the Port Commission.

SPOKANE—City Council will order construction of first unit of new intersecting sewer. Cost $18,000. Morton McCartney, city engineer. A project is under way for curb lighting and electroliers on First avenue. Estimated cost $70,000. C. M. Fassett, commissioner.——Henry C. Mitchen has purchased a site for packing and cold storage plant.——Commissioner C. M. Fassett is contemplating improvements on the upriver pumping plant with water power pumps, costing from $100,000 to $125,000.

TACOMA—Resolution 6379 for laying cement sidewalks on a number of streets has been ordered. W. D. Nickeus, city clerk. Resolution 6378 for re-grading certain streets has been ordered.——Goodyear Logging Co., Inc., capital stock $200,000; C. A. Goodyear of Tomah, Wisconsin, N. B. Solner, cashier Union Savings & Trust Co. of Seattle. Logging operations will commence January 1; six miles of road will be built.——Notice has been given for improvement district No. 430. Various streets are to be graded, paved, including sidewalks and gutters.

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Personal

S. O. JAYNE is state irrigation engineer for Washington.

J. B. OGBORN has been appointed city architect for Richmond, California.

F. G. COTTRELL has been appointed chief chemist for the U. S. Bureau of Mines.

CARL L. KNIGHT will be appointed chief deputy city engineer for Sacramento, California.

E. J. BARTELS has joined the staff of Falkenburg & Laucks, engineers of Seattle, Washington.

CLARENCE H. MATSON has been appointed traffic manager for the Los Angeles Harbor Commission.

JOHN SHRADER, of Pasadena, California, has become manager for the Eldora Oil Company of Maricopa.

DEWITT L. REABURN has been appointed locating engineer for the Alaska Engineering Commission.

WILLIAM PAUL GERHARD, sanitary engineer of New York, has been in Seattle on professional business.

R. H. OBER, consulting engineer of Seattle, Washington, has removed his office to 1011 Alaska building, Seattle.

C. M. MEANS of Pittsburgh, Pennsylvania, has been appointed consulting electrical engineer for the U. S. Bureau of Mines.

C. M. EDGETT, geological engineer of Kennewick, Washington, has returned from a trip to examine gas deposits north of this city.

I. S. VOORHEES, engineer for the Klamath branch of the U. S. Reclamation Service, has been transferred to the Umatilla project.

B. A. ETCHEVERRY, professor of irrigation for the University of California, has been in Oroville for the purpose of inspecting his interests.

GEORGE DILLMAN has been elected president and GEORGE H. MEYERS secretary for the City Planning Commission of Alameda, California.

WESLEY RICHARDS has resigned his position as superintendent for the Oakdale Irrigation District and has been succeeded by WILBUR LOWNEY.

H. T. TAYLOR has been appointed division engineer in charge of the construction of the Cascade Scenic highway in King county, Washington.

JOHN F. RICHARDSON, of the engineering staff of the U. S. Reclamation Service, has been in Salt Lake City on his way to the Yuma project.

W. A. WILLIAMS, of San Francisco, has been selected to head the newly organized department of petroleum technology for the U. S. Bureau of Mines.

CHARLES H. LEE, consulting engineer of Los Angeles, has been retained by the city in regard to litigation pending with the College Ranch Company.

L. F. VAILE, of the engineering staff of the California State Highway Commission, is making the survey for the Oroville lateral for the state highway.

RUFUS HOLMAN, King county commissioner of Washington, conducted a party of city and county officials on an inspection trip over the Columbia Highway.

C. P. DEXTER, formerly of the county engineer's staff of Seattle, Washington, has been appointed an assistant engineer to the Alaska Engineering Commission.

THOMAS BERRY, of Berry & Winterhalter, consulting engineers of San Francisco, has been retained in a consulting capacity by the Modesto Irrigation District.

DR. SAMUEL PORTER, chief of irrigation investigation for the U. S. Department of Agriculture, has been in Spokane, Washington, on his annual tour of inspection.

CHARLES GEDDES was to have sailed from New York on August 4 for Constantinople, Turkey, to take charge of the Standard Oil Company's interests at that point.

B. K. STROUD, petroleum engineer of San Francisco, has gone to Coalinga on professional business with reference to the appraisal of properties for the Independent Oil Producers' Agency.

C. J. BLANCHARD, statistician for the U. S. Reclamation Service, has recently delivered an address on Reclamation before the students of the Isaacs-Woodbury business college at Los Angeles.

J. A. ROSS has been appointed chief deputy city engineer for Fresno, California, to succeed ANDREW M. JENSEN, who has resigned to take a course of advanced study at the University of California.

ALLAN M. HIRSH, of the Lock Joint Pipe Company, New York, was a recent visitor in San Francisco after inspecting the work under way on the Sooke Water Supply Project at Victoria, B. C.

ALBERT GIVAN has resigned his position as city engineer for Sacramento, California, and has been succeeded by F. C. MILLER, formerly county surveyor, who in turn will be succeeded by DRURY BUTLER.

A. N. JOHNSON has resigned his position as chief engineer for the Illinois State Highway Commission to join the engineering staff of the Bureau of Municipal Research with headquarters at 261 Broadway, New York.

J. C. WEST, formerly manager of the San Francisco office of the Sullivan Machinery Company, has been appointed general sales engineer with headquarters in Chicago. RAY P. MCGRATH has been transferred from Boston to take charge of the San Francisco office.

W. H. SHEARMAN, commissioner of the department of water supply for Salt Lake City, accompanied by CHARLES F. BARRETT, superintendent of water works; SYLVESTER Q. CANNON, city engineer; and H. K. BURTON, water engineer, have been examining City Creek canyon as a source of possible water storage for flood waters.

A. GRIFFIN, formerly superintendent of irrigation for the Truckee-Carson project of the U. S. Reclamation Service at Fallon, Nevada, has been appointed chief engineer and manager for the South San Joaquin Irrigation District at Manteca, California. Mr. Griffin will continue as consulting engineer for the Waterford Irrigation District.

Commercial Paragraphs

WESTERN PIPE & STEEL CO. is erecting steel oil storage tanks for the Lakeview Oil Co. No. 2 to handle the output of the great No. 2 Lakeview gusher.

THE CALIFORNIA ARIZONA CONSTRUCTION CO., C. S. KENT president, has taken over all the contracts and equipment of the BARBER ASPHALT PAVING CO. in California.

J. H. MACGREGOR of FALKENBURG & LAUCKS, Seattle, Washington, has secured a contract for inspecting and testing 3800 tons of steel for the Meier & Frank building and also for testing the steel for Portland public dock No. 2.

GENERAL ELECTRIC COMPANY has sold a Curtis turbo-generator 1000 kw. capacity to the Hammond Lumber Co. at Tongue Point, near Astoria, Oregon. Condensing apparatus was sold by CHARLES C. MOORE & CO., ENGINEERS, through W. H. CRAWFORD, manager at Seattle.

JOSEPH T. RYERSON & SON announce the establishment of warehouses in St. Louis, Missouri, for immediate service in their lines of finished steel, and have taken over the plant, merchandise, equipment, and good will of the W. G. HAGAR IRON COMPANY.

R. F. WARE, ditching contractor of Los Angeles, has returned from an Eastern trip during which he purchased a No. 10 gasoline driven Buckeye ditcher to be used for a 100,000-ft. sewer contract at San Diego. Mr. Ware is also contractor for 40 miles of municipal trench at Riverside, California.

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